Section: Anaesthesiology

Original Research Article

COMPARISON OF PERICAPSULAR NERVE GROUP BLOCK AND FASCIA ILIACA COMPARTMENT BLOCK FOR PREOPERATIVE ANALGESIA IN PATIENTS UNDERGOING HIP SURGERY UNDER SPINAL ANAESTHESIA: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Hip fractures cause severe pain, particularly during movement and positioning for spinal anaesthesia. Fascia iliaca compartment block (FICB) and pericapsular nerve group (PENG) block are commonly used regional analgesic techniques. PENG block targets articular branches supplying the anterior hip capsule and may provide effective preoperative analgesia. The aim is to compare the analgesic efficacy of PENG block and FICB in adults undergoing hip surgery under spinal anaesthesia.

Materials and Methods: In this randomized controlled trial, 90 patients were allocated equally to receive ultrasound-guided PENG block (Group P, n=45) or FICB (Group F, n=45). Visual Analogue Scale (VAS) scores were recorded at rest and during movement before and 30 minutes after block administration. Haemodynamic parameters were recorded at rest and during passive leg raise. Continuous variables were compared using an independent-samples t-test and categorical variables using the chi-square test or Fisher's exact test. A p value <0.05 was considered statistically significant.

Results: Baseline characteristics and preblock VAS scores were comparable. At 30 minutes, VAS scores were significantly lower in the PENG group at rest (2.24 ± 0.63 vs 3.96 ± 0.72; p<0.001) and during movement (3.38 ± 0.70 vs 5.02 ± 0.76; p<0.001). At rest, postblock systolic and diastolic blood pressures were lower in the PENG group, while heart rate did not differ significantly. During passive leg raise, postblock heart rate and blood pressures were significantly lower in the PENG group. No block-related complications were observed.

Conclusion: PENG block provided superior short-term preoperative analgesia compared with FICB, with lower VAS scores at rest and during movement 30 minutes after block administration.

Keywords: Pericapsular nerve group block, fascia iliaca compartment block, hip surgery, spinal anaesthesia, regional anaesthesia, Visual Analogue Scale.

INTRODUCTION

Hip fracture is a common orthopaedic emergency, particularly among elderly patients, and is associated with significant pain, morbidity, functional decline and mortality.[1] Early surgery, adequate analgesia and multidisciplinary perioperative care are central components of modern

hip fracture management.[2-4] Regional anaesthesia is commonly preferred in many patients undergoing hip fracture surgery because it may reduce pulmonary complications and support early postoperative recovery when used as part of a structured care pathway.[5]

Pain in hip fracture patients is often severe during movement, transport, radiological evaluation and positioning for spinal anaesthesia. Poorly controlled perioperative pain is associated with delayed mobilization, increased opioid exposure, delirium and poorer functional outcomes.[6,7] Standard multimodal analgesia and regional nerve blocks are therefore recommended to improve pain control and reduce reliance on systemic opioids.[2-4,7]

Fascia iliaca compartment block is a widely used regional analgesic technique for hip fracture pain. It acts by depositing local anaesthetic beneath the fascia iliaca, allowing spread toward the femoral nerve, lateral femoral cutaneous nerve and, variably, the obturator nerve.[8,11,12] However, incomplete obturator nerve coverage and possible quadriceps weakness may limit its effectiveness in some patients, particularly when dynamic pain and spinal positioning are assessed.[9,12]

The anterior hip capsule receives important sensory innervation from articular branches of the femoral nerve, obturator nerve and accessory obturator nerve.[9] Based on this anatomical understanding, the pericapsular nerve group block was introduced as a motor-sparing block targeting the articular branches supplying the anterior hip capsule.[10] Since its description, PENG block has gained attention as a potentially effective technique for preoperative analgesia, positioning for neuraxial anaesthesia and postoperative pain control in hip surgery.

Pain assessment using validated scales such as the Visual Analog Scale or Numerical Rating Scale remains important for evaluating block efficacy, although elderly patients may require careful explanation and repeated assessment for reliable scoring.[13] Randomized controlled trials comparing PENG block and fascia iliaca compartment block are still evolving, and reporting should follow transparent randomized trial principles such as CONSORT recommendations.[14] Therefore, the present study was designed to compare the analgesic efficacy of PENG block and FICB in adult patients undergoing hip surgery under spinal anaesthesia.

Aim

To compare the analgesic efficacy of pericapsular nerve group block and fascia iliaca compartment block in adult patients undergoing hip surgery under spinal anaesthesia.

Objectives

1. To compare preblock and 30-minute postblock VAS scores at rest and during movement between PENG block and FICB groups.
2. To compare hemodynamic parameters and block-related complications between the two groups.

MATERIALS AND METHODS

Study Design and Participants: This randomized controlled trial was conducted in the Department of Anaesthesiology at Sri Balaji Medical College Hospital and Research Institute from January 2025 to June 2026 . The study was undertaken after approval from the Institutional Ethics Committee and written informed consent was obtained from all participants before enrolment. Adult patients aged 18–80 years, with American Society of Anesthesiologists (ASA) physical status I or II, body mass index <35 kg/m², and scheduled to undergo hip surgery under spinal anaesthesia were considered eligible. Exclusion criteria included refusal to participate, infection at the proposed block site, known allergy to local anaesthetic agents, coagulopathy, chronic opioid therapy, severe cognitive impairment preventing reliable pain assessment, polytrauma, ipsilateral inguinal hernia, or a pre-existing neurological deficit involving the affected limb.

Sample Size Calculation: The sample size was estimated using OpenEpi software version 2.3.1, considering a 95% confidence level and 80% statistical power. Based on assumptions derived from previously published studies comparing regional analgesic techniques for hip surgery, the minimum required sample size was estimated as 41 patients per group. The target sample size was increased to 45 patients per group, resulting in a total sample size of 90 patients.

Randomization, Allocation Concealment and Blinding: A total of 90 eligible patients were randomized in a 1:1 ratio using a computer-generated randomization sequence. Allocation concealment was maintained using sealed, opaque envelopes. Forty-five patients were allocated to Group P and received an ultrasound-guided pericapsular nerve group (PENG) block, while 45 patients were allocated to Group F and received an ultrasound-guided fascia iliaca compartment block (FICB).

Because the two blocks differed technically, the anaesthesiologist performing the intervention was not considered blinded to group allocation. However, pain scores and haemodynamic parameters were recorded by an observer blinded to the assigned intervention.

A total of 94 patients were assessed for eligibility, of whom 4 were excluded before randomization. Ninety patients were randomized equally to the pericapsular nerve group (PENG) block group and the fascia iliaca compartment block (FICB) group, with 45 patients in each group. All allocated participants received the assigned intervention, there were no losses to follow-up or discontinuations, and all 90 patients were included in the final analysis.

FICB: fascia iliaca compartment block; **PENG:** pericapsular nerve group block.

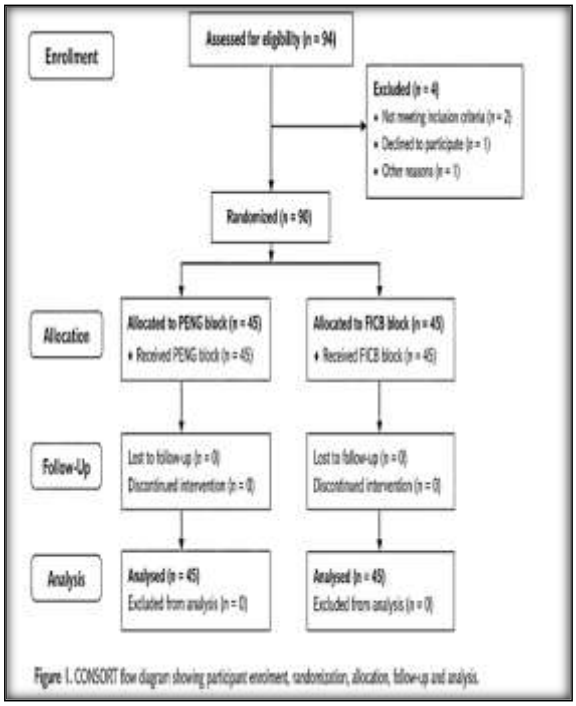

Figure 1: CONSORT flow diagram of participant enrolment, allocation, follow-up and analysis. FICB = fascia iliaca compartment block; PENG = pericapsular nerve group block.

Preblock Assessment

After arrival in the operating room, standard monitoring comprising electrocardiography, non-invasive blood pressure monitoring and pulse oximetry was instituted. Baseline heart rate, systolic blood pressure, diastolic blood pressure, oxygen saturation and pain scores were recorded.

Pain intensity was assessed using the Visual Analogue Scale (VAS) at rest and during passive movement. For dynamic assessment, with the patient in the supine position, the affected lower limb was gently raised to approximately 15°, and the corresponding VAS score was recorded.

Regional Block Technique

Both blocks were performed under aseptic precautions and ultrasound guidance with the patient in the supine position.

PENG Block

For the PENG block, a curvilinear ultrasound probe was placed transversely over the anterior inferior iliac spine and rotated approximately 45° to align with the pubic ramus. The iliopsoas muscle and tendon, femoral artery, pectineus muscle and iliopubic eminence were identified.

A 22-gauge, 100-mm block needle was advanced in-plane from lateral to medial until its tip was positioned in the musculofascial plane between the anterior aspect of the psoas tendon and the posterior pubic ramus. Following negative aspiration, 20 mL of 0.25% bupivacaine was administered in 5-mL increments under ultrasound visualization to confirm appropriate local anaesthetic spread.

Fascia Iliaca Compartment Block

For FICB, a linear ultrasound probe was positioned over the inguinal region to identify the sartorius muscle, fascia iliaca, iliacus muscle, femoral nerve and femoral vessels. A 100-mm, 20-gauge short-bevel block needle was advanced under ultrasound guidance into the plane beneath the fascia iliaca.

After negative aspiration and confirmation of appropriate interfascial spread, 30 mL of 0.25% bupivacaine was administered incrementally in 5-mL aliquots.

Postblock Assessment

Patients were continuously monitored after block administration. Thirty minutes after the block, VAS scores were reassessed at rest and during passive leg raise to approximately 15° by an observer blinded to group allocation. Heart rate, systolic blood pressure and diastolic blood pressure were recorded at the same assessment points. Following completion of the study assessments, patients proceeded to spinal anaesthesia according to the institutional protocol.

Outcome Measures

The primary outcome measures were the VAS scores at rest and during passive movement 30 minutes after block administration.

Secondary outcomes included preblock and 30-minute postblock heart rate, systolic blood pressure and diastolic blood pressure at rest and during passive leg raise, together with the occurrence of block-related complications.

Block-related complications assessed during the study period included vascular puncture, haematoma, local anaesthetic systemic toxicity, failed block and neurological complications.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version 19.2.1 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation and compared between groups using the independent-samples t-test. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test, as appropriate. A p value <0.05 was considered statistically significant.

RESULTS

Ninety patients were randomized, with 45 patients allocated to the PENG group (Group P) and 45 to the FICB group (Group F). All participants received the allocated intervention, there were no losses to follow-up or post-randomization exclusions, and all 90 patients were included in the final analysis. [Figure 1]

Baseline demographic and surgical characteristics were comparable between the groups. The mean age was 65.10 ± 11.80 years in the PENG group and 64.40 ± 9.10 years in the FICB group (p=0.754). Gender distribution and type of surgical procedure were also comparable. [Table 1]

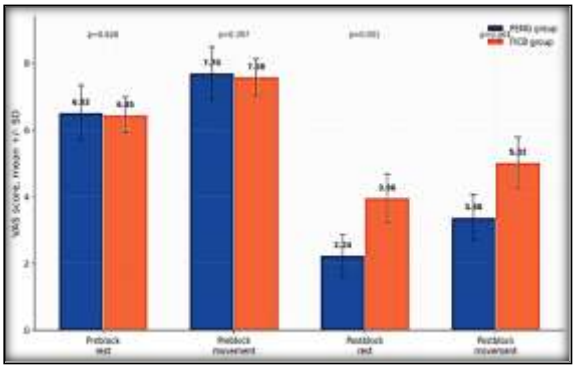

Figure 1: Comparison of VAS scores before and after block

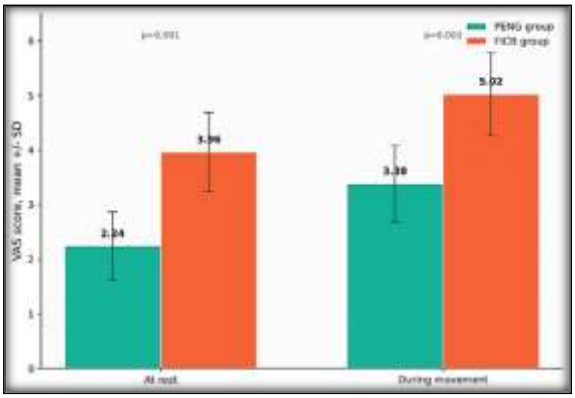

Figure 2: Thirty-minute postblock VAS scores

Table 1: Baseline Demographic and Surgical Characteristics

Variable	PENG group (n=45)	FICB group (n=45)	p value
Age, years, mean ± SD	65.10 ± 11.80	64.40 ± 9.10	0.754
Gender, male/female, n	25/20	23/22	0.673
Procedure, IT/arthroplasty/CRIF, n	30/13/2	28/17/0	0.308*

***Exact test used because of small expected cell frequencies.**

IT: intertrochanteric fracture; CRIF: closed reduction internal fixation; PENG: pericapsular nerve group; FICB: fascia iliaca compartment block; SD: standard deviation.

Preblock VAS scores at rest and during movement were comparable between the two groups. Thirty minutes after block administration, the mean VAS score at rest was significantly lower in the PENG group than in the FICB group (2.24 ± 0.63 vs 3.96 ± 0.72; p<0.001). Similarly, the 30-minute VAS score during movement was significantly lower in the PENG group (3.38 ± 0.70 vs 5.02 ± 0.76; p<0.001) [Table 2].

Table 2: Comparison of Preblock and 30-Minute Postblock VAS Scores

VAS assessment	PENG group (n=45)	FICB group (n=45)	p value
Preblock VAS at rest	6.52 ± 0.81	6.45 ± 0.54	0.628
Preblock VAS during movement	7.70 ± 0.78	7.58 ± 0.55	0.397
30-minute postblock VAS at rest	2.24 ± 0.63	3.96 ± 0.72	<0.001
30-minute postblock VAS during movement	3.38 ± 0.70	5.02 ± 0.76	<0.001

Values are presented as mean ± SD.

VAS: Visual Analogue Scale; **PENG:** pericapsular nerve group; **FICB:** fascia iliaca compartment block; **SD:** standard deviation.

Preblock haemodynamic parameters at rest were comparable between the two groups. At 30 minutes after block administration, systolic blood pressure (125.40 ± 8.70 vs 130.80 ± 7.50 mmHg; p=0.002) and diastolic blood pressure (77.30 ± 6.90 vs 85.70 ± 5.20 mmHg; p<0.001) were significantly lower in the PENG group. In contrast, postblock heart rate did not differ significantly between the groups (82.90 ± 7.80 vs 85.20 ± 5.40 beats/min; p=0.107) [Table 3].

Table 3: Haemodynamic Parameters Before and 30 Minutes after Block at Rest

Parameter	PENG group (n=45)	FICB group (n=45)	p value
Preblock HR, beats/min	91.90 ± 7.20	94.20 ± 5.90	0.103
Preblock SBP, mmHg	141.60 ± 10.40	142.10 ± 8.60	0.803
Preblock DBP, mmHg	86.40 ± 5.70	86.10 ± 5.10	0.793
Postblock HR, beats/min	82.90 ± 7.80	85.20 ± 5.40	0.107
Postblock SBP, mmHg	125.40 ± 8.70	130.80 ± 7.50	0.002
Postblock DBP, mmHg	77.30 ± 6.90	85.70 ± 5.20	<0.001

Values are presented as mean ± SD.

HR: heart rate; **SBP:** systolic blood pressure; **DBP:** diastolic blood pressure; **PENG:** pericapsular nerve group; **FICB:** fascia iliaca compartment block.

During passive leg raise, preblock heart rate, systolic blood pressure and diastolic blood pressure were comparable between the groups. Thirty minutes after block administration, heart rate (86.50 ± 7.70 vs 91.80 ± 5.30 beats/min), systolic blood pressure (130.80 ± 7.20 vs 138.20 ± 8.60 mmHg) and diastolic blood pressure (81.40 ± 6.20 vs 88.70 ± 5.30 mmHg) were significantly lower in the PENG group than in the FICB group (all p<0.001) [Table 4].

Table 4: Haemodynamic Parameters during Passive Leg Raise

Parameter	PENG group (n=45)	FICB group (n=45)	p value
Preblock HR, beats/min	97.10 ± 8.10	99.60 ± 5.80	0.096
Preblock SBP, mmHg	145.90 ± 18.60	149.70 ± 9.40	0.226
Preblock DBP, mmHg	90.10 ± 6.90	92.00 ± 5.40	0.149
Postblock HR, beats/min	86.50 ± 7.70	91.80 ± 5.30	<0.001
Postblock SBP, mmHg	130.80 ± 7.20	138.20 ± 8.60	<0.001
Postblock DBP, mmHg	81.40 ± 6.20	88.70 ± 5.30	<0.001

Values are presented as mean ± SD.

HR: heart rate; **SBP:** systolic blood pressure; **DBP:** diastolic blood pressure; **PENG:** pericapsular nerve group; **FICB:** fascia iliaca compartment block.

No block-related complications were observed in either group during the study period. There were no reported cases of vascular puncture, haematoma, local anaesthetic systemic toxicity, failed block or neurological complications.

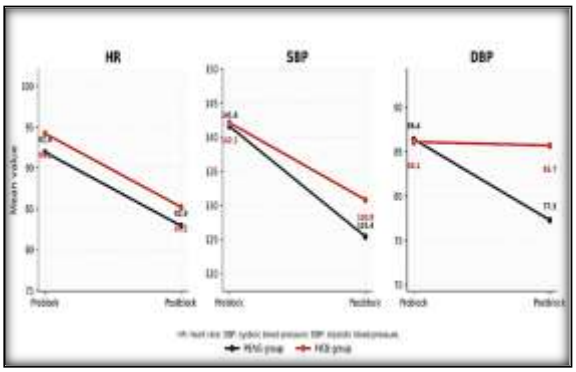

Figure 3: Hemodynamic changes at rest before and after block

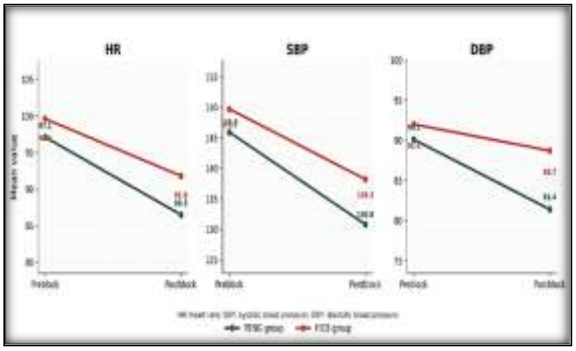

Figure 4: Hemodynamic changes during passive leg raise

DISCUSSION

The present randomized controlled trial compared ultrasound-guided pericapsular nerve group (PENG) block with fascia iliaca compartment block (FICB) for preoperative analgesia in patients undergoing hip surgery under spinal anaesthesia. The principal finding was that PENG block was associated with significantly lower VAS scores 30 minutes after block administration, both at rest and during passive movement. At rest, postblock systolic and diastolic blood pressures were lower in the PENG group, whereas heart rate did not differ significantly between groups. During passive leg raise, postblock heart rate, systolic blood pressure and diastolic blood pressure were lower in the PENG group. No block-related complications were observed.

These findings are consistent with the randomized study by Kalashetty et al., who demonstrated significantly lower postblock VAS scores with PENG block compared with FICB in patients undergoing hip surgery under spinal anaesthesia.[15] Senthil et al. similarly reported better sensory analgesia and greater preservation of quadriceps motor function with PENG block,[16] while Natrajan et al. observed favourable postoperative analgesic effects with PENG compared with FICB in patients undergoing hip fracture surgery,[17] Mosaffa et al. also reported better early analgesia, delayed first analgesic requirement and lower morphine consumption with PENG block.[18]

The favourable effect of PENG block on movement-related pain is anatomically plausible. The block targets the articular branches of the femoral, obturator and accessory obturator nerves supplying the anterior hip capsule.[9,10] This more selective approach may provide effective capsular analgesia while limiting motor involvement. Jadon et al. found both PENG and suprainguinal fascia iliaca blocks effective for positioning during spinal anaesthesia, with favourable positioning-related analgesia in the PENG group.[19] Lin et al. also demonstrated improved short-term analgesia with PENG block compared with femoral nerve block.[20]

Evidence from hip arthroplasty has further explored the potential motor-sparing effect of PENG block. Choi et al. compared PENG with suprainguinal FICB in total hip arthroplasty,[21] while Aliste et al. reported potential preservation of motor function with PENG compared with suprainguinal fascia iliaca block.[22] Although these populations differ from patients presenting with acute hip fracture, the findings support the anatomical rationale for selective blockade of sensory branches supplying the hip capsule.

More recent studies indicate that the relative efficacy of PENG and FICB is influenced by the technique used, local anaesthetic volume, timing of assessment and whether static or dynamic pain is evaluated. Keskes et al. found both techniques effective for perioperative analgesia, with PENG providing better analgesia during positioning for spinal anaesthesia.[23] Pavithra et al. similarly reported clinically useful analgesia with both PENG and FICB.[24] Conversely, Dai et al. demonstrated that FICB itself is an effective analgesic technique

capable of reducing pain and opioid consumption in older patients with hip fracture.[25]

Importantly, recent comparative evidence has not uniformly demonstrated superiority of PENG block. Koh et al. reported comparable reductions in dynamic pain with PENG and suprainguinal FICB,[26] whereas Di Pietro et al. found greater early pain reduction with PENG compared with infrainguinal fascia iliaca block during the first hour after intervention.[27] A recent systematic review and meta-analysis by Vermazen et al. likewise found no consistent difference in postoperative pain scores between PENG and FICB across several assessment periods, although pooled opioid consumption favoured PENG in some analyses and the certainty of evidence varied.[28] These findings suggest that differences between the two blocks should be interpreted in the context of the specific technique, clinical setting and outcome assessed.

The lower postblock blood pressure measurements observed in the PENG group in the present study may be compatible with attenuation of the sympathetic response accompanying improved pain relief. However, haemodynamic variables are influenced by multiple clinical factors and were secondary outcomes in this study. They should therefore not be interpreted as direct evidence of superior haemodynamic stability.

Overall, the present findings support PENG block as an effective option for short-term preoperative analgesia, particularly when movement-related pain is clinically important. FICB nevertheless remains an established, effective and widely practiced regional analgesic technique, and the choice of block should consider operator expertise, institutional protocols, patient characteristics and the desired clinical outcome.

Strengths

1. Randomized controlled design: Participants were randomized in a 1:1 ratio with equal allocation to the PENG and FICB groups.
2. Blinded outcome assessment: Postblock pain scores and haemodynamic parameters were recorded by an observer blinded to group allocation, reducing assessment bias.
3. Standardized ultrasound-guided interventions: Both blocks were performed using predefined ultrasound-guided techniques and standardized concentrations and volumes of local anaesthetic.
4. Assessment of both static and dynamic pain: VAS scores were assessed at rest and during passive movement, providing clinically relevant information regarding movement-associated pain.
5. Objective secondary measurements: Heart rate, systolic blood pressure and diastolic blood pressure were evaluated before and after block administration at rest and during passive leg raise.
6. Complete short-term follow-up: All 90 randomized participants were included in the final analysis, with no post-randomization losses or exclusions.
7. Safety assessment: Block-related complications were prospectively monitored and reported.

Limitations

1. The study was conducted at a single centre, which may limit the generalizability of the findings.
2. Although the study sample was adequate for the planned comparison, it was not sufficiently large to assess uncommon block-related adverse events.
3. The principal analgesic assessment was limited to 30 minutes after block administration; therefore, the findings predominantly reflect early preoperative analgesic efficacy.
4. Quadriceps motor strength was not formally evaluated, preventing direct assessment of the potential motor-sparing advantage of PENG block.
5. Patient-centred outcomes such as time to mobilization, length of hospital stay, patient satisfaction and long-term functional recovery were not evaluated.
6. Because of technical differences between the blocks, the anaesthesiologist performing the intervention could not be blinded to group allocation.
7. Haemodynamic variables were secondary outcomes and may be influenced by several perioperative factors; therefore, they should not be interpreted as direct measures of analgesic efficacy or haemodynamic stability.

Clinical Implications

The findings suggest that ultrasound-guided PENG block is an effective option for short-term preoperative analgesia in patients undergoing hip surgery, particularly when movement-related pain is clinically important. Its targeted anatomical approach may provide an advantage when minimizing dynamic pain before spinal anaesthesia is a priority. However, the present findings should not be interpreted as establishing universal superiority of PENG block over FICB, as relative effectiveness may vary according to block approach, local anaesthetic regimen, patient characteristics and outcome assessed.

Future Directions

1. Future randomized trials should evaluate the duration of analgesia beyond the initial 30-minute assessment period.
2. Quadriceps muscle strength should be systematically assessed to determine whether PENG block provides a clinically meaningful motor-sparing advantage.
3. Future studies should include patient-centred outcomes such as time to mobilization, patient satisfaction, length of hospital stay and functional recovery.
4. Larger multicentre randomized controlled trials are required to improve generalizability and evaluate uncommon complications.

5. Direct comparisons of PENG block, conventional FICB and suprainguinal FICB using standardized local anaesthetic concentrations, volumes and assessment intervals are warranted.
6. Both static and dynamic pain outcomes should be reported using standardized assessment methods to facilitate comparison between studies and future meta-analysis.

CONCLUSION

Ultrasound-guided PENG block provided superior short-term preoperative analgesia compared with FICB in patients undergoing hip surgery under spinal anaesthesia, with significantly lower VAS scores at rest and during passive movement 30 minutes after block administration. Lower postblock haemodynamic measurements were also observed in the PENG group in selected comparisons, particularly during passive leg raise; however, these secondary findings should not be interpreted as evidence of superior haemodynamic stability. No block-related complications were observed during the study period.

Further multicentre studies incorporating longer follow-up, postoperative analgesic consumption, motor-function assessment and patient-centred functional outcomes are warranted.

Ethics Approval

The study was conducted after approval from the Institutional Ethics Committee of Sri Balaji Medical College Hospital and Research Institute, Tirupati, Andhra Pradesh, India. The study was conducted in accordance with applicable institutional ethical standards and the principles governing biomedical research involving human participants.

Informed Consent

Written informed consent was obtained from all participants before enrolment in the study. Participants were informed regarding the nature of the study, the regional anaesthetic procedure, study medications, postoperative assessments, and their right to withdraw from participation.

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