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Original Article

Anaesthesia Section

Efficacy of Ultrasound-guided Pericapsular Nerve Group Block versus Suprainguinal Fascia Iliaca Compartment Block in Proximal Femur Fractures: A Randomised Double-blinded Clinical Study

ROSHIN REEBA JOSEPH[1], MA SHIRIL ASHRAF[2], BINCY V THOMAS[3]

ABSTRACT

Introduction: Regional anaesthesia techniques such as the Suprainguinal Fascia Iliaca Compartment (S-FICB) block and the Pericapsular Nerve Group (PENG) block provide effective analgesia for patients with hip fractures. The PENG block is considered superior to other hip joint blocks, such as the femoral nerve block and fascia iliaca block, particularly because it preserves quadriceps femoris motor function.

Aim: To compare the efficacy of S-FICB and PENG blocks in facilitating optimal positioning of proximal femur fracture patients for spinal anaesthesia.

Materials and Methods: This double-blinded, randomised clinical study was conducted at the Department of Anaesthesiology, Government Medical College, Kottayam, Kerala, India. A total of 60 patients aged 18-75 years, belonging to American Society of Anaesthesiologists (ASA) physical status classification I and II, undergoing elective surgery for proximal femur fractures under subarachnoid block, were enrolled. Patients were sequentially allocated into two groups of 30 each. Each group received either S-FICB or PENG block under ultrasound guidance using 20 mL of 0.2% ropivacaine. The primary outcome measure was the difference in Numerical Rating Scale (NRS) pain scores at Rest (NRS-R) and on passive 15° leg lifting (NRS-D), measured every 10 minutes up to 30 minutes after the block in both groups. Secondary outcomes included comparison of Ease of Spinal Positioning (EOSP) scores between PENG and S-FICB groups and evaluation of haemodynamic parameters before and after Peripheral Nerve Block (PNB) and after positioning for Subarachnoid Block (SAB). Categorical variables were analysed using the Chi-square test and continuous variables using Student's t-test. A p-value <0.05 was considered as statistically significant.

Results: Both groups were comparable in demographic variables. The mean±SD age was 65.93±10.91 years in Group A and 63.57±12.37 years in Group B. Group A consisted of 30% males and 70% females, while Group B had 50% males and 50% females. NRS scores reduced significantly in both the PENG and S-FICB groups. The mean±SD EOSP score was 2.07±0.74 in the S-FICB group and 2.43±0.50 in the PENG group (p-value <0.05), indicating significantly greater ease of positioning in the PENG group.

Conclusion: Both blocks resulted in a significant and comparable reduction in NRS pain scores. However, the immediate reduction in pain was more pronounced in the PENG group compared to the S-FICB group. Therefore, the PENG block improves ease of positioning for subarachnoid block in patients with proximal femur fractures.

Keywords: Pain management, Positioning, Subarachnoid block

INTRODUCTION

In patients with proximal femur fractures, early surgical fixation is important for rapid recovery, particularly in the elderly [1], and to prevent complications such as pneumonia and deep venous thrombosis resulting from prolonged immobilisation [1,2]. Administering anaesthesia to these patients can be challenging due to intense pain, and adequate analgesia is essential to prevent psychological stress [3]. Systemic analgesics such as opioids are commonly used but are associated with side-effects including nausea, vomiting, delirium, and respiratory depression, which are more pronounced in elderly patients [4].

Subarachnoid block is the preferred anaesthetic technique for fixation of proximal femur fractures. Regional blocks such as the femoral nerve block [5,6] and fascia iliaca compartment block [6-8] provide effective analgesia for patient positioning prior to subarachnoid block. These techniques are relatively easy to perform and safe but may result in postoperative quadriceps weakness [9,10]. The PENG block is a novel technique introduced in 2018. It blocks the articular branches of the femoral nerve, obturator nerve, and accessory obturator nerve supplying the anterior hip capsule [11]. By targeting sensory branches, it potentially spares motor function [12,13]. Case reports and randomised controlled trials suggest that the PENG block is an effective alternative for pain relief in proximal femur fractures [12,14-17].

Although multiple studies highlight the benefits of PENG [11,18-20] and fascia iliaca blocks [8,21] individually in hip surgeries, literature directly comparing the analgesic efficacy of PENG and S-FICB for positional pain during spinal anaesthesia is limited [12]. This gap prompted the present study. It was hypothesised that the PENG block would provide superior analgesia, thereby increasing the ease of positioning for spinal anaesthesia.

The primary outcome was the difference in NRS pain scores at rest (NRS-R) and during passive 15° leg lifting (NRS-D), measured every 10 minutes up to 30 minutes post-block in both groups. Secondary outcomes included comparison of EOSP scores and assessment of haemodynamic parameters before and after PNB, and after positioning for SAB.

MATERIALS AND METHODS

The present randomised, double-blinded clinical study was conducted from May 2024 to January 2025 (nine months) in the Department of Anaesthesiology, Kottayam Medical College, Kottayam, Kerala, India following Institutional Review Board clearance (IRB No. 40/2024). Patients meeting these inclusion criteria were enrolled in the study after obtaining written informed consent for participation and for the use of their data for research purposes while maintaining confidentiality.

Inclusion criteria: A total of 60 patients, aged 18-75 years, of either sex, belonging to ASA grade I or II, with proximal femur fractures (including neck of femur, intertrochanteric, and subtrochanteric fractures), undergoing surgery under spinal anaesthesia, and experiencing significant pain (NRS ≥4) were included in the study.

Exclusion criteria: Patient refusal, bleeding disorders or coagulopathy, local infection at the injection site, significant cardiopulmonary disease, history of drug allergy, polytrauma, inability to express pain scores (e.g., hearing impairment, cognitive impairment, dementia, or psychiatric illness), and patients on chronic opioid therapy were excluded from the study.

Sample size calculation: The sample size was calculated based on a study by Jadon A et al., [12], in which the EOSP score (mean±SD) was 1.39±0.49 (1.22-1.53) with S-FICB and 2.15±0.6 (1.94-2.35) with PENG. The p-value was <0.0001, indicating statistical significance. The required sample size (N) was calculated using the formula for comparison of two means.

$$N=\frac{(Z_\alpha+Z_\beta)^2\times SD^2\times 2}{(M1+M2)^2}$$

$$=\frac{(2.56+1.28)^2\times 0.42^2\times 2}{(2.15+1.39)^2}$$

Z at 1% α error=2.58 (99% confidence interval)

Z at 10% β error=1.28 (power of the study is 90%)

$$SD^2=\frac{SD_1^2+SD_2^2}{2},$$

where SD_1=0.6 and SD_2=0.49.

Mean M_1=2.15, Mean M_2=1.39

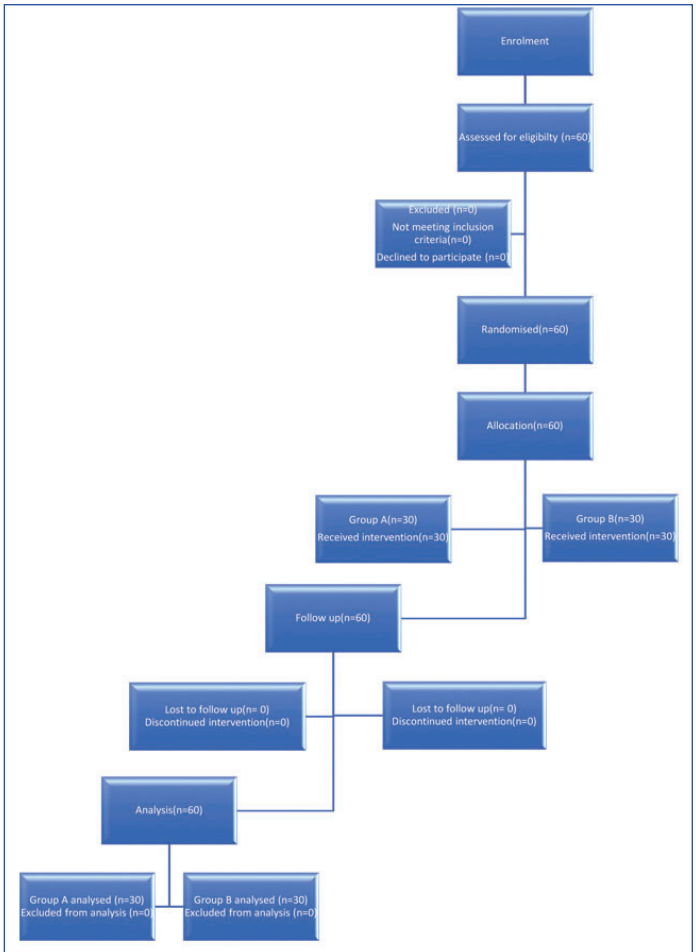
The calculated sample size (N) was 18 patients per group. To account for potential participant dropouts or invalid data and to ensure the reliability of statistical results, it was decided to randomly assign 30 patients to each group.

Study Procedure

Patients scheduled for proximal femur fracture surgery were interviewed during the preanaesthesia check-up. Information regarding age, gender, co-morbidities, and the presence of any exclusion criteria was collected. Routine preoperative investigations were performed, including Complete Blood Count (CBC), Liver Function Tests (LFT), Renal Function Tests (RFT), serum electrolytes, Bleeding Time (BT), Clotting Time (CT), Prothrombin time/International Normalised Ratio (PT/INR), Electrocardiogram (ECG), and X-ray.

Patients were thoroughly explained the anaesthesia procedure and the NRS for pain assessment, and written informed consent was obtained using a standardised proforma. All patients were kept fasting for 8 hours and received oral ranitidine 150 mg and metoclopramide 10 mg the night before and on the day of surgery.

In the preoperative room, intravenous access was secured, and fluids were initiated. Patients were randomly assigned to two equal groups of 30 each: PENG block and S-FICB [Table/Fig-1]. Double-blinding and objective assessment of outcomes were implemented to minimise bias. Random allocation was performed by an independent statistician using a computer-generated randomisation



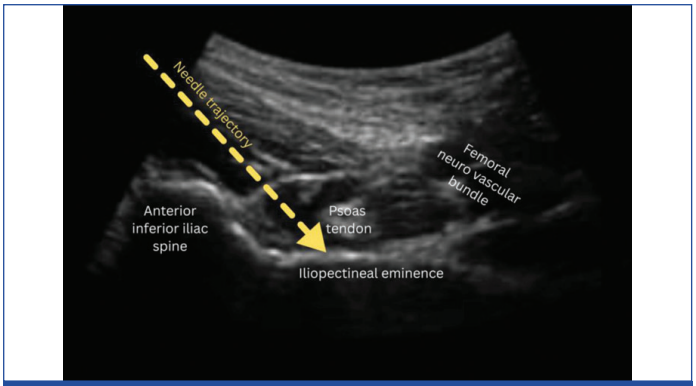
[Table/Fig-1]: CONSORT flow diagram.

table. Patient enrollment was carried out by the principal investigator and co-investigators after eligibility assessment. An independent anaesthesiologist, not involved in patient care or data collection, administered the assigned block. Both the patient and the observer anaesthesiologist were blinded to group allocation and the procedure performed.

Group A received 20 mL of 0.2% ropivacaine as an ultrasound-guided PENG block, while Group B received 20 mL of 0.2% ropivacaine as an ultrasound-guided S-FICB. Drug dosages were based on previous studies [18,19,22]. Pain was assessed pre-procedure at rest (NRS-R) and during movement (NRS-D) with 15° passive elevation of the affected limb. Pain was recorded on the NRS, where 0=no pain, 1-3=mild pain, 4-6=moderate pain, 7-9=severe pain, and 10=worst imaginable pain [23]. All patients were instructed on the use of NRS before scoring. All blocks were performed in the supine position under strict aseptic conditions.

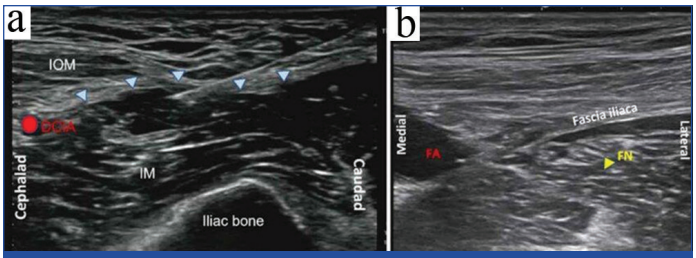
PENG block: A low-frequency curvilinear probe was placed above the anterior inferior iliac spine and moved inferiorly to visualise the pubic ramus. The iliopectineal eminence, femoral artery, and iliopsoas muscle were identified. A 10-cm block needle was inserted in-plane to target the space between the iliopectineal eminence and pubic ramus, avoiding injury to the femoral nerve. After confirming the needle tip position, 20 mL of 0.2% Ropivacaine was injected incrementally (5 mL each) with negative aspiration. Ultrasound confirmed local anaesthetic spread between the psoas muscle and pubic ramus [Table/Fig-2].

S-FICB: With the patient supine, a linear probe (6-14 MHz) was placed in the sagittal plane over the Anterior Superior Iliac Spine (ASIS) and moved medially to identify the fascia iliaca, sartorius, iliopsoas, and internal oblique muscles. After identifying the 'bowtie sign' formed by the fasciae, a 10-cm needle was introduced 1 cm cephalad to the inguinal ligament using an in-plane approach. The needle tip was positioned beneath the fascia iliaca, and hydro-



[Table/Fig-2]: Sono-anatomy of pericapsular nerve group block.
Ultrasound image showing needle trajectory for PENG block targeting the iliopsoas plane between the psoas tendon and iliopectineal eminence

dissection separated the fascia from the iliacus muscle. The local anaesthetic was considered successfully administered when spread was observed superior to the point where the iliacus muscle passes under the abdominal muscles [Table/Fig-3].



[Table/Fig-3]: Sono-anatomy of suprainguinal fascia iliaca block.
Ultrasound-guided suprainguinal fascia iliaca compartment block (FICB): (a) local anaesthetic injection between the fascia iliaca and iliacus muscle in the parasagittal oblique view; (b) After LA injection, satisfactory local anaesthetic spreading around the femoral nerve in the transverse view; DCIA: Deep circumflex iliac artery; FA: Femoral artery; triangle: fascia iliaca, FN: Femoral nerve; IM: Iliacus muscle; IOM: Internal oblique muscle

After the block, non invasive blood pressure, ECG, pulse oximetry, and signs of local anaesthetic toxicity were monitored for 30 minutes. Analgesia was assessed every 10 minutes up to 30 minutes post-block using NRS-R and NRS-D. Patients were then shifted to the operating room, where standard monitoring with non invasive blood pressure, pulse oximeter, and five-lead ECG was applied.

Spinal anaesthesia was administered in the sitting position using 0.5% heavy bupivacaine with titrated doses of fentanyl by an anaesthesiologist not involved in the study. Comfort during sitting for subarachnoid block was assessed using the EOSP score.

Outcome measures: The primary outcome was the difference in NRS pain scores at NRS-R and on passive 15° leg lifting NRS-D every 10 minutes up to 30 minutes post-block. Secondary outcomes included EOSP scores and haemodynamic changes before and after PNB and after positioning for SAB.

The EOSP score was graded as follows: 0=unable to position; 1=abnormal posture due to pain requiring support; 2=minimal discomfort, no support needed; 3=optimal condition, patient positions himself without pain [12,24]. Block failure was defined as inability to sit with NRS ≥4, and additional analgesia was provided with intravenous fentanyl 1 µg/kg. All patients received standard intraoperative care and 1 g intravenous paracetamol before surgical closure and thrice daily postoperatively.

STATISTICAL ANALYSIS

Data were analysed using Statistical Package for the Social Sciences (SPSS) software version 25.0. Continuous variables were assessed for normality and presented as mean±SD. Independent t-tests were used for between-group comparisons, and paired t-tests for within-group comparisons. Categorical data were analysed using the Chi-square test. A p-value <0.05 was considered as statistically significant.

RESULTS

All 60 patients completed the study without dropouts. Categorical variables, including age, gender, and ASA classification, were comparable between the two groups [Table/Fig-4].

Parameters	Group A (n=30)	Group B (n=30)	χ^2	p-value
Age (years) (Mean±SD)	65.93±10.91	63.57±12.37		0.435
Gender (Male/Female)	9 (30%)/21 (70%)	15 (50%)/15 (50%)	2.5	0.114
ASA classification (I/II)	6 (20%)/24 (80%)	6 (20%)/24 (80%)	0	1

[Table/Fig-4]: Demographic and clinical characteristics between the groups.

There were no abnormalities noted in the blood investigations, including CBC, LFT, RFT, serum electrolytes, BT, CT, and PT/INR. ECG and X-ray findings were also normal.

Primary outcome: The NRS scores at rest and on movement were comparable between the two groups before the block (p-value=0.877 and 0.687, respectively). Thirty minutes after the block, NRS scores reduced significantly in both groups. In the PENG block group, the mean±SD scores decreased from 6.73±0.868 and 8.17±0.699 to 3.03±0.183 and 3.23±0.430 at rest and on movement, respectively. In the S-FICB group, scores decreased from 6.70±0.794 and 8.23±0.568 to 3.0±0.0 and 3.23±0.430, respectively [Table/Fig-5-7].

Secondary outcome: A statistically significant improvement in ease of positioning for spinal anaesthesia in the PENG group was observed [Table/Fig-8].

NRS R and D-Time interval	Group A (Mean±SD)	Group B (Mean±SD)	p-value
NRS-R	6.73±0.868	6.70±0.794	0.877
NRS-R'10 mins	4.40±0.621	4.60±0.675	0.237
NRS-R'20 mins	3.17±0.379	3.20±0.407	0.744
NRS-R'30 mins	3.03±0.183	3.00±0.0	0.321
NRS-D	8.17±0.699	8.23±0.568	0.687
NRS-D'10 mins	5.57±0.728	5.73±0.907	0.436
NRS-D' 20 mins	3.77±0.430	3.83±0.461	0.565
NRS-D '30 mins	3.23±0.430	3.23±0.430	1.0

[Table/Fig-5]: NRS-R and NRS-D comparison between the groups.

Group		Mean±SD	p-value
Group A	NRS-R	6.73±0.868	0.001
	NRS-R' 10 mins	4.40±0.621	
	NRS-R	6.73±0.868	0.001
	NRS-R' 20 mins	3.17±0.379	
	NRS-R	6.73±0.868	0.001
	NRS-R' 30 mins	3.03±0.183	
Group B	NRS-R	6.70±0.794	0.001
	NRS-R'10 mins	4.60±0.675	
	NRS-R	6.70±0.794	0.001
	NRS-R'20 mins	3.20±0.407	
	NRS-R	6.70±0.794	0.001
	NRS-R'30 mins	3.00±0.00	

[Table/Fig-6]: NRS-R comparison within the groups.

Haemodynamic changes showed no significant difference between the two groups. However, within-group analysis revealed a significant reduction in heart rate from baseline at 10, 20, and 30 minutes after each block (p-value=0.001) [Table/Fig-9]. Systolic and diastolic blood pressures also showed a statistically significant reduction at 20 and 30 minutes post-block compared to baseline (p-value=0.001) [Table/Fig-10,11].

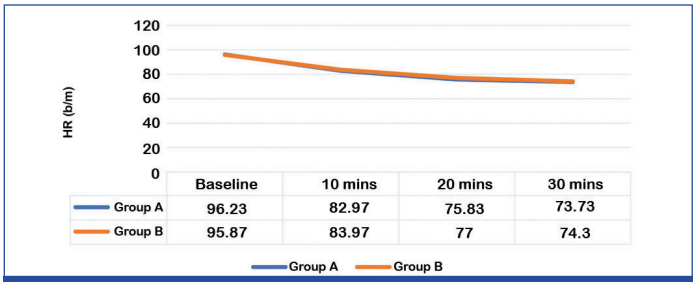
None of the patients required additional fentanyl boluses in either group, and no block-related complications were observed.

Group		Mean±SD	p-value
Group A	NRS-D	8.17±0.699	0.001
	NRS-D'10 mins	5.57±0.78	
	NRS-D	8.17±0.699	0.001
	NRS-D'20 mins	3.77±0.430	
	NRS-D	8.17±0.699	0.001
	NRS-D'30 mins	3.23±0.430	
Group B	NRS-D	8.23±0.568	0.001
	NRS-D'10 mins	5.73±0.907	
	NRS-D	8.23±0.568	0.001
	NRS-D'20 mins	3.83±0.461	
	NRS-D	8.23±0.568	0.001
	NRS-D'30 mins	3.23±0.430	

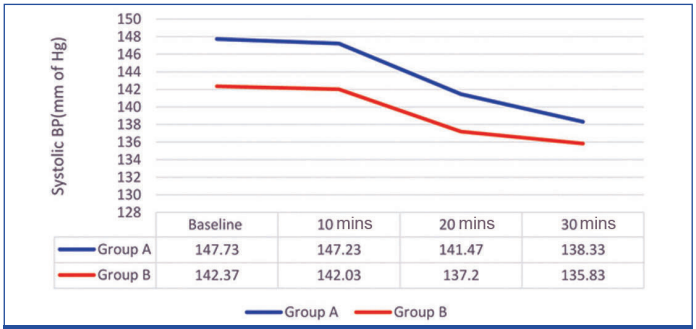
[Table/Fig-7]: NRS-D comparison within the groups.

	Group	Mean±SD	t	p-value
EOSP	Group A	2.43±0.504	2.24	*0.029
	Group B	2.07±0.740		

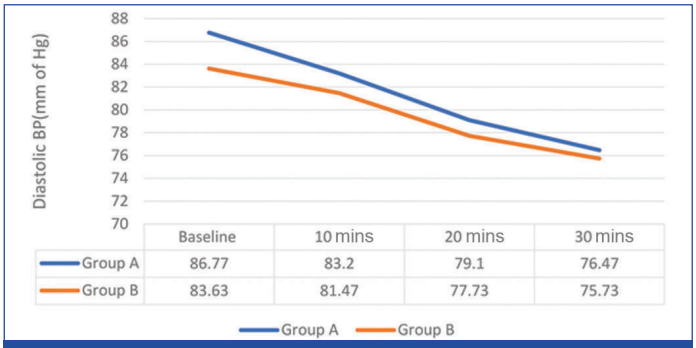
[Table/Fig-8]: EOSP comparison between the groups.
p-value * is significant



[Table/Fig-9]: Intergroup comparison of mean heart rate.



[Table/Fig-10]: Intergroup comparison of mean systolic BP.



[Table/Fig-11]: Intergroup comparison of mean diastolic BP.

DISCUSSION

The PENG block is a novel regional anaesthesia technique first described by Girón-Arango L et al., as an approach to reduce postoperative pain and 24-hour opioid consumption in hip surgery patients. In their initial study of five patients, a significant median decrease in NRS scores was observed. Compared with Femoral Nerve Block (FNB) and FICB, the PENG block showed a potential motor-sparing effect, with no quadriceps weakness postoperatively [11].

The PENG block is a plane block performed under ultrasound guidance, involving the injection of a large volume of local anaesthetic into the musculofascial plane between the psoas tendon and the pubic ramus [11]. The anterior hip capsule, which contains most of the sensory innervation of the hip joint, is supplied by articular branches of the femoral, obturator, and accessory obturator nerves [25]. The posterior capsule is predominantly supplied by the nerve to the quadratus femoris, with minor contributions from the sciatic and superior gluteal nerves [26]. By targeting the anterior hip capsule, the PENG block provides analgesia while sparing motor function, a key advantage over femoral and fascia iliaca blocks and essential for early ambulation.

In the present study, both PENG and S-FICB blocks effectively reduced positional pain during spinal anaesthesia for proximal femur surgeries. While both blocks significantly decreased NRS scores, the PENG block was superior in alleviating positional pain, supporting its use for preoperative hip fracture analgesia due to its motor-sparing properties. This facilitates early rehabilitation and reduces complications associated with prolonged motor blockade.

Senthil KS et al., evaluated 40 ASA PS 1 and 2 patients and reported significant quadriceps sparing in the PENG group at 18 and 24 hours postoperatively, enabling early mobilisation [16]. Natarajan P et al., in a study of 24 patients, demonstrated that PENG block provided superior postoperative pain relief and decreased rescue analgesic requirements compared to FICB [14]. Mosaffa T et al., found significant reductions in VAS scores at 15 minutes post-block and 12 hours postoperatively in the PENG group compared to FICB (p-value =0.031; p-value=0.021) [15]. Kalashetty MB et al., observed that PENG block significantly improved analgesia for positioning prior to spinal anaesthesia compared to FICB [17]. Thakur S et al., reported lower NRS scores and better positioning with continuous PENG block versus continuous FICB [27]. Jadon A et al., and Baheti S and Yerramshetty M, also demonstrated superior analgesia and EOSP scores with PENG block compared to S-FICB [12,28].

In the present study, haemodynamic parameters were comparable between groups, confirming that both blocks are effective and safe. Within each group, significant reductions in heart rate and blood pressure were noted post-block (p-value=0.001), consistent with previous studies by Kalashetty MB et al., and Juneja D et al., [17,29].

Limitation(s)

This study included only ASA I and II patients. Postoperative assessment of quadriceps motor power would have provided additional insight into the true motor-sparing effect of the PENG block.

CONCLUSION(S)

Multiple regional nerve blocks, such as femoral block, fascia iliaca block, and PENG block, are used to manage perioperative pain in proximal femur fractures. This study demonstrates that the PENG block provides superior analgesia compared to the suprainguinal fascia iliaca block and significantly improves ease of positioning for subarachnoid block. By targeting the articular branches of the anterior hip capsule, the PENG block spares motor function, which is critical for early rehabilitation and the prevention of complications associated with prolonged quadriceps weakness.

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PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Anaesthesiology, Government Medical College, Kottayam, Kerala, India.
2. Assistant Professor, Department of Anaesthesiology, Government Medical College, Kottayam, Kerala, India.
3. Assistant Professor, Department of Anaesthesiology, Government Medical College, Kottayam, Kerala, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Roshin Reeba Joseph,
Flat 9A, Abad Royal Gardens, Old MC Road, Thellakom,
Kottayam-686630, Kerala, India.
E-mail: roshinreeba@ymail.com

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