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Comparison of Ultrasound-Guided Peng Block Versus Femoral Nerve Block for Facilitating Spinal Anaesthesia Positioning in Hip Fracture Surgery: A Prospective Comparative Study

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ABSTRACT

Background: Effective pain management in patients with hip fractures is essential for facilitating optimal positioning during spinal anaesthesia. Conventional techniques such as femoral nerve block may provide incomplete analgesia and are associated with motor blockade. The pericapsular nerve group (PENG) block is a newer regional anaesthesia technique that targets the articular innervation of the hip joint while preserving motor function.
Aim: To compare the efficacy and safety of ultrasound-guided PENG block and femoral nerve block in facilitating patient positioning for spinal anaesthesia in hip fracture surgeries.
Methods: This prospective observational comparative study was conducted on 76 patients with proximal femur fractures undergoing surgery under spinal anaesthesia. Patients were allocated into two groups: Group I (PENG block, n = 38) and Group II (femoral nerve block, n = 38). Pain during positioning was assessed using the Visual Analogue Scale (VAS). Secondary outcomes included postoperative pain scores, motor block, time to rescue analgesia, and hemodynamic parameters. Statistical analysis was performed using SPSS version 21.0, with $p < 0.05$ considered significant.
Results: Baseline characteristics were comparable between the groups. The PENG block group demonstrated significantly lower pain scores during positioning and at all postoperative time points. Motor blockade was significantly less in the PENG group, indicating a motor-sparing effect. The duration of analgesia was longer, with delayed requirement for rescue analgesia in the PENG group. Hemodynamic parameters were comparable between the groups throughout the study period.
Conclusion: The ultrasound-guided PENG block provides superior analgesia during positioning for spinal anaesthesia, prolonged postoperative pain relief, and better preservation of motor function compared to femoral nerve block. It is a safe and effective alternative for perioperative pain management in hip fracture surgeries.

Keywords: *Pericapsular nerve group block; Femoral nerve block; Hip fracture; Spinal anaesthesia; Positioning pain; Regional anaesthesia; Postoperative analgesia.*

INTRODUCTION

Hip fracture is a major cause of morbidity, mortality, and functional dependence among adults, particularly in the elderly population, and represents a growing global public health concern. With increasing life expectancy and a rising prevalence of osteoporosis, the incidence of hip fractures has escalated worldwide, placing a substantial burden on healthcare systems. These injuries are frequently associated with severe pain, prolonged hospitalization, increased healthcare costs, and a significant decline in quality of life [1]. Early surgical intervention is widely recommended to reduce complications such

as thromboembolism, pneumonia, pressure sores, and mortality, making perioperative management a critical determinant of patient outcomes [2].

Spinal anaesthesia is commonly preferred for hip fracture surgeries due to its advantages over general anaesthesia, including reduced intraoperative blood loss, lower incidence of thromboembolic events, improved postoperative analgesia, and decreased pulmonary complications [3]. However, successful administration of spinal anaesthesia requires optimal patient positioning, typically in the sitting or lateral decubitus position. Patients with hip fractures often experience intense pain during movement, which significantly impairs their ability to achieve and maintain the required position. Inadequate analgesia during positioning can lead to patient discomfort, multiple attempts, prolonged procedure time, haemodynamic instability, and increased reliance on systemic analgesics or sedatives, which may result in adverse effects such as respiratory depression, delirium, and cardiovascular complications, especially in elderly individuals with multiple comorbidities [4].

Traditionally, systemic analgesics such as opioids and non-steroidal anti-inflammatory drugs have been used to manage pain in these patients. However, their use is often limited by side effects, particularly in the geriatric population. Opioids are associated with respiratory depression, nausea, vomiting, urinary retention, and delirium, whereas non-steroidal anti-inflammatory drugs may exacerbate renal dysfunction and increase the risk of gastrointestinal bleeding [5]. These limitations have led to an increasing emphasis on regional anaesthesia techniques that provide targeted analgesia while minimizing systemic adverse effects.

Among regional techniques, the femoral nerve block has been widely utilized for pain relief in hip fracture patients. It provides effective analgesia to the anterior thigh and partially to the hip joint by blocking the femoral nerve [6]. However, the hip joint receives sensory innervation not only from the femoral nerve but also from the obturator and accessory obturator nerves, which may not be adequately covered by this technique. Consequently, femoral nerve block may result in incomplete analgesia, particularly during movement. Additionally, it is associated with quadriceps muscle weakness due to motor blockade, which may hinder patient cooperation during positioning and increase the risk of postoperative falls [7].

The pericapsular nerve group (PENG) block is a relatively newer ultrasound-guided regional anaesthesia technique that has gained increasing attention in recent years. It targets the articular branches supplying the anterior hip capsule by depositing local anaesthetic in the fascial plane between the psoas tendon and the superior pubic ramus at the level of the iliopubic eminence [9]. By effectively blocking the articular branches of the femoral, obturator, and accessory obturator nerves while largely sparing motor fibers, the PENG block provides superior analgesia with minimal motor impairment [9]. Preservation of quadriceps strength is particularly advantageous, as it facilitates patient positioning and promotes early mobilisation.

The advent of ultrasound guidance has further enhanced the safety and efficacy of peripheral nerve blocks by allowing real-time visualization of anatomical structures, needle placement, and spread of local anaesthetic. This has led to improved success rates and reduced complications such as vascular puncture, nerve injury, and local anaesthetic systemic toxicity [10]. Both femoral nerve block and PENG block are commonly performed under ultrasound guidance, making them suitable for comparison in contemporary anaesthetic practice.

Although several studies have evaluated the role of peripheral nerve blocks in hip fracture management, the evidence comparing PENG block with femoral nerve block remains inconsistent. While some studies have demonstrated superior analgesia with PENG block, particularly during movement, others have reported comparable outcomes between the two techniques [11]. Moreover, many studies have focused primarily on postoperative pain rather than the clinically significant outcome of pain during positioning for spinal anaesthesia. In the Indian context, where healthcare settings often face challenges such as delayed presentation, comorbid conditions, and limited resources, optimizing perioperative analgesia while minimizing opioid use is particularly important [12].

Despite the growing interest in PENG block, there is a paucity of Indian studies directly comparing its efficacy with femoral nerve block in facilitating patient positioning for spinal anaesthesia in hip fracture surgeries. Therefore, this study aims to evaluate and compare the effectiveness of ultrasound-guided PENG block and femoral nerve block in improving patient comfort and positioning during spinal anaesthesia, while also assessing postoperative analgesia and safety outcomes.

MATERIALS AND METHODS

Study Design and Setting: This prospective observational comparative study was conducted in the Department of Anaesthesiology at Travancore Medical College Hospital, Kollam, a tertiary care teaching institution. The study was carried out over a period of 18 months after obtaining approval from the Institutional Ethics Committee.

Study Population: The study included patients of either gender presenting with proximal femur fractures and scheduled for surgical fixation under spinal anaesthesia.

Sample Size: The sample size was calculated based on a previous study using postoperative Visual Analogue Scale (VAS) scores, assuming a 95% confidence level and 80% power, with a 20% allowance for non-response. A total of 76 patients were included and divided into two groups:

- Group I (PENG block): 38 patients
- Group II (Femoral nerve block): 38 patients

Sampling Technique: Eligible patients were enrolled consecutively based on predefined inclusion and exclusion criteria. Allocation into either group was determined by the regional anaesthesia technique administered by the attending anaesthesiologist.

Inclusion Criteria

- Patients of any age and gender with proximal femur fractures (neck of femur, intertrochanteric, or subtrochanteric fractures)
- American Society of Anesthesiologists (ASA) physical status I–III
- Patients planned for surgery under spinal anaesthesia
- Patients providing written informed consent

Exclusion Criteria

- ASA physical status IV or above
- Surgery duration exceeding 150 minutes
- Acute or chronic kidney disease
- Neurological deficits or neuropathy of the operative limb
- Coagulopathy
- Chronic opioid use (>3 months)
- Known hypersensitivity to local anaesthetics
- Old fractures (>7 days)
- Polytrauma patients
- Local infection at the injection site
- Patients unable to comprehend pain scoring systems
- Patients unwilling to participate

Preoperative Assessment and Preparation: All patients underwent a detailed pre-anaesthetic evaluation, including medical history, physical examination, and relevant investigations. Patients were educated regarding the Visual Analogue Scale (VAS) for pain assessment. Standard fasting guidelines were followed. Preoperative medications included oral pantoprazole 40 mg and alprazolam 0.5 mg administered the night before surgery.

Anaesthetic Procedure

Group I – PENG Block: Patients received an ultrasound-guided pericapsular nerve group (PENG) block in the supine position under strict aseptic precautions. A low-frequency curvilinear transducer was used to identify anatomical landmarks, including the anterior inferior iliac spine and iliopubic eminence. Using an in-plane lateral-to-medial approach, 15–20 mL of 0.2% ropivacaine was injected into the fascial plane between the psoas tendon and the superior pubic ramus after negative aspiration.

Group II – Femoral Nerve Block: Patients received an ultrasound-guided femoral nerve block at the inguinal region. The femoral nerve was identified lateral to the femoral artery. Using an in-plane or out-of-plane technique, 15–20 mL of 0.2% ropivacaine was injected beneath the fascia iliaca after confirming negative aspiration.

Spinal Anaesthesia Technique: Thirty minutes after block administration, spinal anaesthesia was performed in the sitting position under aseptic precautions using a 25-gauge Quincke needle. A total of 3 mL of 0.5% hyperbaric bupivacaine was administered intrathecally. Sensory block was assessed using the pin-prick method, and motor block was evaluated using the Modified Bromage Scale.

Outcome Measures

Primary Outcome

- Pain during positioning for spinal anaesthesia assessed using the Visual Analogue Scale (VAS) at 30 minutes after block administration

Secondary Outcomes

- Postoperative pain scores (VAS at rest and during movement) at 2, 6, 10, 14, 18, and 24 hours
- Hemodynamic parameters (heart rate and mean arterial pressure)
- Degree and duration of motor block
- Time to first rescue analgesic requirement
- Patient satisfaction scores
- Incidence of complications or adverse effects
- Duration of hospital stay

Data Collection : Data were recorded using a predesigned structured proforma during the perioperative and postoperative periods until discharge.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) version 21.0. Continuous variables were expressed as mean ±standard deviation, and categorical variables were presented as frequencies and percentages. The Independent t-test was used to compare means between the two groups, and appropriate statistical tests were applied where necessary. A p-value of <0.05 was considered statistically significant.

Ethical Considerations: Ethical clearance was obtained from the Institutional Ethics Committee prior to commencement of the study. Written informed consent was obtained from all participants. Confidentiality of patient data was maintained throughout the study, and no additional financial burden was imposed on participants.

RESULTS

A total of 76 patients with proximal femur fractures were included and equally distributed into two groups: PENG block (Group I) and femoral nerve block (Group II). All participants were analysed.

The two groups were comparable with respect to age, gender, ASA physical status, and body mass index, with no significant differences observed between them (Table 1).

Table 1: Baseline Characteristics of Study Participants

Variable	Group I (PENG) (n=38)	Group II (FNB) (n=38)	Total (n=76)
Age (years)			
< 60	11 (28.9%)	3 (7.9%)	14 (18.4%)
≥ 60	27 (71.1%)	35 (92.1%)	62 (81.6%)
Mean ± SD	-	-	70.25 ± 10.36
Gender			
Male	21 (55.3%)	19 (50.0%)	40 (52.6%)
Female	17 (44.7%)	19 (50.0%)	36 (47.4%)
ASA Status			
ASA I	4 (10.5%)	5 (13.2%)	9 (11.8%)
ASA II	24 (63.2%)	26 (68.4%)	50 (65.8%)
ASA III	10 (26.3%)	7 (18.4%)	17 (22.4%)
BMI (kg/m²)			
Underweight	1 (2.6%)	2 (5.3%)	3 (3.9%)
Normal	10 (26.3%)	9 (23.7%)	19 (25.0%)
Overweight	7 (18.4%)	4 (10.5%)	11 (14.5%)
Obese	20 (52.6%)	23 (60.5%)	43 (56.6%)
Mean ± SD BMI	-	-	25.5 ± 4.1

Pain scores at baseline were similar in both groups. However, patients receiving the PENG block experienced significantly lower pain during positioning for spinal anaesthesia compared to the femoral nerve block group.

This difference persisted across all postoperative time points, with consistently lower pain scores observed in the PENG group, indicating superior analgesic efficacy both during positioning and in the postoperative period (Table 2).

Table 2: Comparison of Pain Scores (VAS) Between Groups

Time Point	Group I (PENG) Mean ± SD	Group II (FNB) Mean ± SD	p-value
Baseline	8.74 ± 1.10	8.32 ± 1.01	0.08
Positioning	**1.87 ± 1.07**	**3.68 ± 1.56**	**<0.001**
15 min	2.00 ± 1.00	3.34 ± 1.51	<0.001
45 min	1.83 ± 1.07	3.31 ± 1.46	<0.001
1 hour	1.92 ± 1.03	3.79 ± 1.78	<0.001
1.5 hours	2.39 ± 0.91	4.02 ± 1.43	<0.001
2 hours	3.26 ± 1.29	4.66 ± 1.85	<0.001
4 hours	2.80 ± 1.57	5.33 ± 2.45	<0.001
6 hours	3.64 ± 1.51	5.53 ± 2.58	<0.001
12 hours	3.84 ± 1.92	5.69 ± 1.93	<0.001
24 hours	3.66 ± 1.68	5.08 ± 2.12	0.002

Patients in the femoral nerve block group demonstrated significantly higher motor blockade during the early postoperative period. In contrast, the PENG block group showed minimal motor involvement, highlighting its motor-sparing advantage (Table 3).

Table 3: Comparison of Motor Block (Modified Bromage Score)

Time Point	Group I (PENG) Mean ± SD	Group II (FNB) Mean ± SD	p-value
Baseline	0	0	-
15 min	1.63 ± 0.48	2.50 ± 0.57	<0.001
45 min	1.47 ± 0.72	2.53 ± 0.51	<0.001
1 hour	0.92 ± 0.78	1.89 ± 0.76	<0.001
1.5 hours	0.16 ± 0.37	1.50 ± 0.51	<0.001
2 hours	0	0.42 ± 0.50	<0.001
≥ 4 hours	0	0	-

The duration of analgesia was significantly longer in the PENG block group, as evidenced by a delayed requirement for rescue analgesia compared to the femoral nerve block group (Table 4).

Table 4: Time to First Rescue Analgesia

Parameter	Group I (PENG)	Group II (FNB)	p-value
Time (minutes) Mean ± SD	**18.93 ± 4.03**	**12.12 ± 2.45**	**<0.001**

Hemodynamic variables, including heart rate and mean arterial pressure, remained comparable between the two groups throughout the study period, indicating similar physiological stability (Table 5).

Table 5: Hemodynamic Parameters (Heart Rate and Mean Arterial Pressure)

Parameter	Group I (PENG) Mean ± SD	Group II (FNB) Mean ± SD	p-value
Heart Rate (Baseline)	77.71 ± 9.50	83.37 ± 13.22	0.035
Heart Rate (Post-op trend)	Lower	Higher	NS
MAP (Baseline)	129.53 ± 16.75	131.53 ± 16.35	0.60

MAP (Post-op trend)	Comparable	Comparable	NS

The PENG block provided superior analgesia during positioning and throughout the postoperative period, with the added advantage of minimal motor blockade and prolonged analgesic duration, while maintaining hemodynamic stability.

DISCUSSION

The present study demonstrates that the ultrasound-guided pericapsular nerve group (PENG) block provides superior analgesia compared to the femoral nerve block for facilitating patient positioning during spinal anaesthesia in hip fracture surgeries. In addition to improved dynamic pain control, the PENG block was associated with reduced motor blockade and prolonged duration of analgesia, while maintaining comparable hemodynamic stability.

Analgesia During Positioning

Pain during positioning for spinal anaesthesia is a critical clinical endpoint in patients with hip fractures, as inadequate analgesia can lead to patient discomfort, difficulty in positioning, increased procedural attempts, and adverse physiological responses. In the present study, patients receiving the PENG block experienced significantly lower pain scores during positioning compared to those receiving a femoral nerve block.

This finding is consistent with multiple Indian studies. Chaudhary et al. reported significantly lower dynamic pain scores with PENG block compared to femoral nerve block during positioning [13]. Similarly, Jeevendiran et al. demonstrated a greater reduction in pain scores and improved patient comfort during spinal positioning in the PENG group [14]. Yadav et al. also observed superior positioning conditions and reduced need for rescue analgesia with the PENG block [15].

International evidence further supports these observations. Erten et al. showed that PENG block significantly reduces pain during hip flexion, lateral positioning, and lumbar flexion compared to femoral nerve block [16]. Kaplan et al. reported improved analgesia and fewer attempts at spinal anaesthesia following preoperative PENG block [17].

The superior analgesic efficacy of the PENG block can be attributed to its anatomical specificity. The anterior hip capsule, which is the principal source of pain during movement, is innervated by articular branches of the femoral, obturator, and accessory obturator nerves. The PENG block effectively targets these branches, providing comprehensive analgesia, whereas femoral nerve block alone may leave obturator-mediated pain unaddressed [18].

Postoperative Analgesia

In the present study, the PENG block provided consistently better postoperative pain relief compared to the femoral nerve block. Effective postoperative analgesia is essential in hip fracture patients, as inadequate pain control can delay mobilisation, increase opioid requirements, and predispose to complications such as delirium and thromboembolism.

These findings align with previous studies. Chaudhary et al. and Jeevendiran et al. both reported lower postoperative pain scores and prolonged analgesia in patients receiving PENG block [13,14]. Duan et al. demonstrated improved dynamic pain control and reduced analgesic demand with continuous PENG block compared to fascia iliaca block [19]. Furthermore, a systematic review and meta-analysis by Li et al. found that PENG block significantly reduces opioid consumption and improves functional outcomes [20].

The sustained analgesic effect observed in the present study may be explained by the targeted blockade of articular nerve branches supplying the hip capsule, which continue to contribute to postoperative pain.

Motor Block and Functional Implications

A key advantage of the PENG block observed in this study was its motor-sparing effect. Patients receiving femoral nerve block exhibited significantly greater motor blockade during the early postoperative period, whereas those in the PENG group demonstrated minimal motor impairment.

This observation is in agreement with several studies. Chaudhary et al., Jeevendiran et al., and Gupta et al. all reported significantly better preservation of quadriceps strength with the PENG block [13,14,21]. Similarly, Erten et al. and Duan et al. highlighted the motor-sparing nature of the PENG block and its role in facilitating early mobilisation [16,19].

The motor-sparing property of the PENG block is particularly important in elderly patients, as it enhances patient cooperation during positioning, reduces the risk of falls, and supports early rehabilitation. In contrast, femoral nerve block often results in quadriceps weakness due to motor fiber involvement, which may compromise functional recovery.

Duration of Analgesia and Rescue Analgesic Requirement

The present study demonstrated a significantly longer duration of analgesia in the PENG group, as reflected by delayed requirement for rescue analgesia. Comparable findings have been reported in the literature. Jeevendiran et al. and Yadav

et al. observed reduced need for rescue analgesics in patients receiving PENG block [14,15]. Kaplan et al. also reported decreased perioperative opioid consumption with the use of PENG block [17]. Additionally, Li et al. demonstrated a significant reduction in cumulative opioid requirement in their meta-analysis [20]. Prolonged analgesia is particularly beneficial in the geriatric population, as it reduces dependence on systemic opioids and minimizes associated adverse effects.

Hemodynamic Stability

In the present study, hemodynamic parameters were comparable between the two groups, with no clinically significant differences observed. However, a trend towards more stable parameters was noted in the PENG group, likely reflecting better pain control. Similar findings have been reported by Erten et al. and Jeevendiran et al., who observed stable hemodynamic profiles in patients receiving PENG block during positioning and perioperative periods [14,16]. Effective analgesia attenuates the sympathetic stress response, which is particularly important in elderly patients with limited cardiovascular reserve.

Clinical Implications

The findings of this study have important clinical implications. The PENG block, by providing superior dynamic analgesia with minimal motor impairment, facilitates optimal positioning for spinal anaesthesia and improves overall perioperative patient comfort. Its opioid-sparing effect and motor-preserving properties make it particularly suitable for integration into enhanced recovery protocols for hip fracture surgeries.

Strengths and Limitations

The strengths of this study include its prospective design, direct comparison of two commonly used ultrasound-guided regional techniques, and evaluation of clinically relevant outcomes such as pain during positioning and motor function. However, certain limitations must be acknowledged. The study was conducted at a single centre with a relatively small sample size, which may limit generalizability. Additionally, the observational design may introduce selection bias. Further multicentric randomized controlled trials with larger sample sizes are warranted to validate these findings.

CONCLUSION

The present study demonstrates that the ultrasound-guided pericapsular nerve group (PENG) block is superior to the femoral nerve block in facilitating patient positioning for spinal anaesthesia in hip fracture surgeries. The PENG block provides significantly better analgesia during positioning and throughout the postoperative period, along with a prolonged duration of analgesia. Importantly, it preserves motor function, thereby enhancing patient cooperation and reducing the risk of postoperative complications related to immobility. Both techniques were associated with comparable hemodynamic stability and safety profiles. In view of its superior analgesic efficacy and motor-sparing advantage, the PENG block represents a valuable and effective regional anaesthetic technique for perioperative pain management in patients undergoing hip fracture surgery. Further large-scale randomized studies are recommended to strengthen the evidence base and support its routine clinical use.

DECLARATIONS

Ethical Approval and Consent to Participate: Ethical approval was obtained from the Institutional Ethics Committee of Travancore Medical College Hospital, Kollam. Written informed consent was obtained from all participants.

Availability of Data and Materials: Data are available from the corresponding author on reasonable request.

Competing Interests: The authors declare no competing interests.

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Authors 'Contributions: All authors contributed to study design, data collection, analysis, and manuscript preparation. All authors approved the final manuscript.

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