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Original Research Article

Pericapsular Precision Versus Compartmental Analgesia: Ultrasound-Guided PENG Block Compared with Fascia Iliaca Block in Patients Undergoing Hip Surgery Under Spinal Anaesthesia

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Conflict of interest: Nil

Abstract:

Background: Effective analgesia before and after hip surgery is essential to facilitate positioning for spinal anaesthesia and improve postoperative recovery. This study compared ultrasound-guided pericapsular nerve group (PENG) block with fascia iliaca compartment block (FICB) in patients undergoing elective hip surgery.

Methods: In this prospective randomized double-blind study, 50 patients scheduled for elective hip surgery under spinal anaesthesia were allocated into two equal groups. Group F received ultrasound-guided FICB and Group P received ultrasound-guided PENG block using 20 mL of 0.5% ropivacaine. Pain was assessed using the Numerical Rating Scale before block, 30 minutes after block, and postoperatively up to 24 hours. Ease of spinal positioning, time to first rescue analgesia, rescue analgesic consumption, and haemodynamic variables were also evaluated.

Results: Baseline demographic and haemodynamic characteristics were comparable between the groups. Pain scores were significantly lower in Group P at 30 minutes and during the early postoperative period up to 8 hours. Group P also showed better ease of positioning, longer time to first rescue analgesia, and lower rescue analgesic consumption over 24 hours. Haemodynamic parameters were stable and similar in both groups.

Conclusion: Ultrasound-guided PENG block provided superior early postoperative analgesia and improved positioning for spinal anaesthesia compared with FICB in elective hip surgery patients.

Keywords: PENG Block; Fascia Iliaca Compartment Block; Hip Surgery; Spinal Anaesthesia; Postoperative Analgesia.

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Introduction

Hip fractures and hip surgeries are common in adults and associated with intense perioperative pain, impaired mobility, prolonged hospitalization, and increased risk of complications. Severe pain during passive limb movement often makes sitting or lateral positioning for spinal anaesthesia (SA) difficult, thereby increasing patient distress and technical difficulty for the anaesthesiologist [1, 2]. Although opioids and non-steroidal anti-inflammatory agents are frequently used for perioperative analgesia, their utility of these in elders is limited due to effects such as respiratory depression, nausea, vomiting, renal dysfunction, and delirium [3]. Consequently, ultrasound-guided regional analgesic techniques have become important component of multimodal analgesia for hip surgery because they reduce systemic analgesic exposure, improve patient comfort and procedure [2, 4]. The fascia iliaca compartment block (FICB) is widely practiced and provides effective analgesia by blocking the femoral and lateral femoral cutaneous nerves, with variable spread to the obturator nerve [3, 4].

The pericapsular nerve group (PENG) block is a newer interfascial technique designed to target the articular branches of the femoral, obturator, and accessory obturator nerves supplying the anterior hip capsule, thereby offering more focused analgesia for hip pain [1, 5]. Recent randomized and pooled evidence suggests that PENG block may provide superior dynamic pain relief, easier positioning for SA, and lower early opioid consumption compared with fascia iliaca-based techniques, although the postoperative analgesic profile to be evaluated [1,2,5]. In this context, a study was undertaken to compare the efficacy of ultrasound-guided PENG block and ultrasound-guided FICB in patients undergoing hip surgery under SA.

Methods

It was a prospective, randomised, double-blind interventional research conducted in Gayatri Vidya Parishad Institute of Health Care and Medical Technology. Study was conducted from October 2025 to January 2026. Protocol was approved by the institutional Ethics Committee. Informed written consent was collected from the study members. Adults undergoing elective hip surgery under SA were included in the research. Those failed to submit informed consent were excluded.

The eligible participants were randomized into two equal groups using a computer-generated randomization sequence with allocation concealment ensured through sealed opaque envelopes. Group F received an ultrasound-guided fascia iliaca compartment block, whereas Group P received an ultrasound-guided pericapsular nerve group block. The study followed a double-blind design in which the anaesthesiologist performing the block was aware of group allocation, but the observer responsible for recording perioperative and postoperative outcomes remained blinded throughout the study. On arrival in the operating room, all patients received standard preoperative preparation. An 18-gauge intravenous cannula was secured, and routine monitoring including electrocardiography, non-invasive blood pressure, and pulse oximetry was instituted. Baseline haemodynamic parameters such as heart rate (HR), blood pressure (BP), and oxygen saturation were recorded prior to block administration. Pain intensity was assessed using the Numerical Rating Scale (NRS) both at rest and during passive elevation of the affected limb by 15 degrees.

In Group F, the fascia iliaca compartment block was administered under ultrasound guidance using strict aseptic precautions. A high-frequency linear ultrasound probe (7–12 MHz) was placed transversely over the inguinal ligament to identify the fascia iliaca, iliacus muscle, and femoral artery. A 22-gauge block needle was then introduced using an in-plane lateral-to-medial approach. After confirming placement of the needle tip beneath the fascia iliaca and obtaining negative aspiration, 20 mL of 0.5% ropivacaine was injected. Correct spread of the local anaesthetic was confirmed by hydrodissection under ultrasound visualization. In Group P, the pericapsular nerve group block was also performed under ultrasound guidance using a low-frequency curvilinear probe. The probe was first positioned over the anterior inferior iliac spine and then moved medially to identify the iliopubic eminence. A 22-gauge block needle was advanced in-plane toward the pericapsular region. Following confirmation of appropriate needle placement and negative aspiration, 20 mL of 0.5% ropivacaine was injected. Adequate spread of local anaesthetic between the psoas muscle and pubic ramus was visualized sonographically. Pain scores were documented before block administration and again 30 minutes after the block in both groups to assess early analgesic response and readiness for positioning for SA.

Thirty minutes after completion of the respective block, patients were positioned for SA. Under full aseptic precautions, SA was administered using a 26-gauge Quincke spinal needle with 3.2 mL of 0.5% hyperbaric bupivacaine. Thereafter, postoperative pain intensity was assessed using the NRS at 2, 4, 6, 8, 12, and 24 hours. Rescue analgesia was administered whenever the NRS score was 4 or more, in the form of intravenous tramadol at a dose of 1.5 mg/kg. All collected data were entered and analyzed using SPSS software version 20 (IBM, Chicago, IL, USA). Continuous variables were compared using Student's t-test, while categorical variables were analyzed using the chi-square test. $P<0.05$ was considered statistically significant.

Results

Total 50 were included, 25 per group. The mean age was 58 ± 8 years in Group F and 59 ± 7 years in Group P (P = 0.68), while body mass index was 24.5 ± 3.2 kg/m² and 24.8 ± 3.1 kg/m², respectively (P = 0.72). Gender distribution and ASA status were also similar (Table 1). Pre-block pain scores were significantly lower in Group P, 7.1 and 7.8 respectively (P = 0.002). At 30 minutes after block administration and during the early postoperative period up to 8 hours, the PENG block group consistently demonstrated lower NRS scores, indicating superior analgesic efficacy (Table 2). However, by 12 and 24 hours, the difference was not statistically significant (Table 2). Ease of spinal positioning (EOSP) was better in Group P, with a higher proportion of patients achieving optimal positioning scores, reflecting greater comfort during positioning for SA. The mean time to first rescue analgesia was significantly prolonged in Group P and total rescue analgesic requirement over 24 hours was significantly lower in the PENG group; 1.9 ± 0.6 vs 2.6 ± 0.7 doses respectively (P = 0.01) (Table 2). Baseline haemodynamic variables including HR, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation were similar in groups and no clinically significant haemodynamic instability was observed (Table 3).

Table 1: Baseline demographic and clinical characteristics among the study members			
Variable	**Group F**	**Group P**	**P value**
Age*	58 ± 8	59 ± 7	0.68
BMI**	24.5 ± 3.2	24.8 ± 3.1	0.72
Male***	15 (60.0)	16 (64.0)	0.85
Female***	10 (40.0)	9 (36.0)	0.85
ASA I/II	14/11	13/12	0.81
*years, mean ± SD; **kg/m², mean ± SD; ***n (%)			

Table 2: Comparison of pain scores and postoperative analgesic outcomes among the study members in groups			
Outcome	**Group F**	**Group P**	**P value**
Pre-block NRS*	7.8	7.1	0.002
NRS at 30 min after block*	3.2	2.5	0.04
Early postoperative pain score (2–8 h)	Higher	Lower	<0.05
NRS at 12 h	Comparable	Comparable	>0.05
NRS at 24 h	Comparable	Comparable	>0.05
Time for first rescue analgesia**	6.5 ± 1.2	7.5 ± 1.1	0.02
Total rescue analgesic doses***	2.6 ± 0.7	1.9 ± 0.6	0.01
*mean; **hours, mean ± SD;***in 24 h, mean ± SD			

Table 3: EOSP and baseline haemodynamics among the study members in groups			
Variable	**Group F**	**Group P**	**p value**
EOSP score 3*	9 (36.0)	10 (40.0)	>0.05
Patients requiring assistance	Similar	Similar	>0.05
HR**	79 ± 6	78 ± 5	0.65
SBP***	128 ± 10	126 ± 9	>0.05
DBP***	Comparable	Comparable	>0.05
MAP***	Comparable	Comparable	>0.05
Oxygen saturation*	Comparable	Comparable	>0.05
*n (%); **beats/min, mean ± SD; ***mmHg, mean ± SD;			

Discussion

The study demonstrated that ultrasound-guided PENG block provided better perioperative analgesic performance than fascia iliaca compartment block in patients undergoing hip surgery. The PENG group had lower pain scores 30 minutes after block placement and throughout the early postoperative period up to 8 hours, better comfort during positioning for SA, a longer time to first rescue analgesia, and lower 24-hour rescue analgesic consumption. These findings are clinically important because hip surgery patients, particularly older adults, often experience severe movement-related pain that complicates sitting or lateral positioning for neuraxial anaesthesia and may increase physiological stress. The better early dynamic analgesia observed with PENG block in the present study is biologically plausible because the technique specifically targets the articular branches to the anterior hip capsule arising from the femoral, obturator, and accessory obturator nerves, whereas conventional fascia iliaca approaches may not reliably cover the obturator contribution to capsular pain [6, 7]. Our findings align with the randomized trial by Mosaffa et al., who reported superior analgesia with PENG compared with fascia iliaca block in hip fracture patients, and with the prospective trial by Keskes et al., in which PENG improved analgesia during positioning for spinal anaesthesia when compared with suprainguinal fascia iliaca block [8, 9]. Recent systematic reviews have also moved in the same direction, suggesting that PENG may reduce early pain intensity and opioid consumption compared with fascia iliaca-based techniques, although heterogeneity remains substantial across trials [10, 11].

An important strength of the present study is the demonstration that the analgesic advantage of PENG block became evident within 30 minutes and persisted through the early postoperative phase. This temporal pattern is consistent with the current literature. A 2024 meta-analysis study demonstrated that PENG block reduced pain during positioning and improved postoperative recovery-related outcomes, including earlier mobility, while maintaining a favourable safety profile [11]. Likewise, newer comparative trials published in 2024 reported that PENG was associated with lower pain during positioning and superior early analgesia when compared with fascia iliaca-based approaches in neck of femur or proximal femur surgery [12, 13]. The present study similarly showed lower NRS

scores at 30 minutes and at 2, 4, 6, and 8 hours, but no significant difference at 12 and 24 hours. This is also in agreement with pooled evidence showing that the superiority of PENG is most pronounced in the early postoperative window, after which the difference narrows as the effect of a single-shot block wanes and systemic multimodal analgesia becomes more dominant [5,9]. Therefore, our data support the view that PENG is particularly valuable when the anaesthesiologist's immediate goal is to improve dynamic pain relief for positioning and to reduce analgesic burden in the first several postoperative hours, rather than to provide prolonged standalone analgesia throughout the first postoperative day [10, 11, 14].

The present study also found that ease of spinal positioning was better in the PENG group, with a higher proportion of patients achieving optimal positioning scores. This outcome is highly relevant in routine anaesthesia practice because better positioning can reduce patient distress, shorten procedural time, and improve the success and safety of spinal anaesthesia. Anatomically, this advantage is again understandable, as movement-evoked pain from the hip capsule is heavily mediated by anterior capsular innervation, which PENG targets more selectively than fascia iliaca block [6, 7]. A prospective randomized study comparing PENG with femoral nerve block before SA also showed that PENG better controlled positioning pain while preserving motor function, suggesting that motor-sparing analgesia is one of its major practical advantages [15]. This motor-sparing property has been emphasized in broader reviews of ultrasound-guided peripheral nerve blocks for hip surgery, which note that PENG has emerged as a technique aimed at balancing effective analgesia with less quadriceps weakness than broader anterior approaches [16]. At the same time, the literature is not entirely uniform. Marrone et al. did not find clear superiority of PENG over fascia iliaca block in elderly proximal femoral fracture patients in the emergency setting, and Pavithra et al. recently reported that while PENG improved preoperative positioning and analgesia, fascia iliaca block provided somewhat longer postoperative analgesia in intertrochanteric fractures [17, 18]. These differences likely reflect variation in patient population, fracture type, local anaesthetic volume and concentration, block timing, ultrasound expertise, and whether the comparator was classical, suprainguinal, or landmark-guided fascia iliaca block. Thus, the present results add to the growing evidence favouring PENG for positioning comfort, while also supporting the need to interpret comparative superiority in the context of technique-specific and population-specific factors [9, 10, 17, 18].

Another clinically meaningful finding in the present study was the significantly longer time to first rescue analgesia and lower total rescue analgesic requirement in the PENG group. These observations indicate an opioid-sparing benefit, which is particularly desirable in elderly orthopaedic patients who are vulnerable to nausea, vomiting, sedation, respiratory depression, delirium, and delayed mobilization. The opioid-sparing effect seen here mirrors the 2023 meta-analysis by Andrade et al., which found reduced cumulative 24-hour opioid consumption with PENG compared with fascia iliaca block [10]. Similar conclusions have been reported in meta-analyses of PENG for hip arthroplasty, where PENG improved pain up to about 6 hours and prolonged the time to first opioid request, though certainty for later outcomes remained lower because of heterogeneity and variable protocols [14, 19]. It is also worth noting that fascia iliaca block remains an effective and evidence-based technique. A systematic review of randomized trials in geriatric hip fracture patients concluded that fascia iliaca block provides meaningful perioperative analgesia, facilitates positioning for spinal anaesthesia, reduces additional analgesic use, and may support earlier mobilization [20]. Therefore, the message from the present study is not that fascia iliaca block is ineffective, but rather that PENG may offer more focused and efficient analgesia for the anterior hip capsule, leading to improved early dynamic pain control and reduced rescue analgesic need. Some investigators have even explored combining PENG with fascia iliaca-based techniques to broaden sensory coverage, particularly for surgeries where cutaneous or lateral thigh components may contribute to pain, further underscoring that optimal block strategy may depend on the exact surgical procedure and analgesic goals [21].

The haemodynamic comparability and absence of clinically significant instability in both groups further support the safety of using either ultrasound-guided regional technique as part of a multimodal strategy. This is especially relevant in older adults, in whom avoiding repeated systemic opioid boluses may help maintain better physiological stability. Nevertheless, the present findings should be interpreted with several limitations. First, the pre-block pain scores were significantly different between groups, with lower baseline pain already present in the PENG group; although randomization was performed properly, this imbalance may have magnified the observed post-block differences and should be acknowledged as a potential confounder. Second, the sample size was modest, which limits precision for secondary outcomes such as patient satisfaction and rare block-related complications. Third, the study evaluated a single-shot technique, so the absence of group differences at 12 and 24 hours does not rule out whether catheter-based or

adjuvant-enhanced approaches could alter the comparative duration of analgesia. Fourth, quadriceps strength, time to ambulation, and delirium-related outcomes were not formally measured, even though recent evidence suggests these may be important differentiators between motor-sparing and broader compartment techniques [11, 16]. Despite these limitations, the study has practical value: it used ultrasound guidance, concealed randomization, blinded postoperative assessment, and clinically relevant outcomes directly applicable to spinal anaesthesia practice. Overall, the present results support PENG block as a preferable option over fascia iliaca compartment block when the primary objectives are easier positioning for spinal anaesthesia and superior early postoperative analgesia after hip surgery, while larger multicentric trials are needed to confirm long-term functional benefits and define the subgroups that derive the greatest advantage [10, 11, 13].

Conclusion: Both ultrasound-guided PENG block and fascia iliaca compartment block were effective regional analgesic techniques for patients undergoing elective hip surgery under spinal anaesthesia. However, the PENG block provided superior early analgesia, improved ease of positioning for spinal anaesthesia, prolonged time to first rescue analgesia, and reduced postoperative rescue analgesic consumption during the first 24 hours. Haemodynamic parameters remained stable and comparable in both groups, indicating that both techniques were safe and well tolerated. Overall, the findings suggest that PENG block may be a preferable option when early dynamic pain relief and patient comfort during positioning are primary clinical goals.

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