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Comparative Evaluation of USG-Guided PENG Block versus Suprainguinal Fascia Iliaca Block for Postoperative Analgesia in Hip Fracture Surgery under Spinal Anaesthesia

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ABSTRACT

Background: Effective perioperative analgesia is essential for optimizing patient comfort and facilitating positioning during spinal anaesthesia in hip fracture surgeries. The pericapsular nerve group (PENG) block and suprainguinal fascia iliaca compartment block (S-FICB) are two ultrasound-guided regional techniques increasingly used for this purpose. This study compared their efficacy in terms of ease of spinal positioning and postoperative analgesia.

Methods: In this prospective, randomized, double-blind study, 60 patients undergoing hip surgery under spinal anaesthesia were allocated to receive either a PENG block or S-FICB using 20 mL of 0.5% ropivacaine. Ease of spinal positioning was evaluated 30 minutes post-block using a 4-point Ease of Spinal Positioning (EOSP) scale. Postoperative pain was assessed at rest and during passive limb elevation at 4, 6, 8, 12, and 24 hours using the Numeric Rating Scale (NRS). Hemodynamic parameters, time to first rescue analgesia, and total tramadol consumption over 24 hours were also recorded.

Results: Demographic characteristics and baseline hemodynamic parameters were comparable between groups. S-FICB resulted in significantly better spinal positioning, with higher mean EOSP scores compared to PENG ($p < 0.00001$). Postoperative NRS scores at all time points were significantly lower in the S-FICB group ($p = 0.0001$). However, time to first rescue analgesia and total 24-hour tramadol requirements did not differ significantly between the groups.

Conclusion: S-FICB provides superior ease of spinal positioning and improved early postoperative analgesia compared with PENG block in patients undergoing hip surgery. Both techniques are safe and offer comparable opioid-sparing effects. S-FICB may be preferred when optimal positioning and enhanced initial pain control are clinical priorities.

Keywords: *Hip fracture surgery; Pericapsular nerve group block; PENG block*

INTRODUCTION:

Hip fractures constitute a significant global health concern, particularly among older adults, and are associated with high morbidity, mortality, and functional decline. Surgical intervention remains the standard of care, and the choice of anaesthetic technique plays a pivotal role in perioperative outcomes.[1] Regional anaesthesia has gained prominence in orthopaedic surgery due to its ability to provide targeted analgesia, reduce opioid consumption, lower the incidence of postoperative nausea and respiratory complications, and facilitate earlier mobilisation. Among hip fractures, femoral neck fractures account for nearly half of all cases and are often associated with severe pain during even minimal movement, making patient positioning for spinal anaesthesia especially challenging.[2]

Inadequate analgesia during positioning may result in agitation, hemodynamic instability, and increased myocardial stress, particularly in elderly or cardiovascularly compromised patients. Systemic analgesics such as opioids, ketamine, and dexmedetomidine have been used perioperatively to mitigate positioning pain; however, these agents carry drawbacks, including respiratory depression, delirium, sedation, and variable analgesic efficacy.[3] Traditional regional techniques such as femoral nerve block (FNB), lumbar plexus blocks, and infrainguinal fascia iliaca compartment block (FICB) have been employed with mixed results. Their limitations stem largely from inconsistent blockade of the articular branches innervating the anterior hip capsule, which is the primary source of nociception after hip injury or surgery.[4]
Recent advances in ultrasound-guided regional anaesthesia have led to the development of more targeted and anatomically precise block techniques. The pericapsular nerve group (PENG) block, introduced in 2018, was specifically designed to anaesthetise the articular branches of the femoral, obturator, and accessory obturator nerves by depositing the local anaesthetic in the musculofascial plane between the psoas tendon and superior pubic ramus. [5] Early reports have demonstrated promising analgesic efficacy with potential motor-sparing effects, a major advantage in the elderly population, where early postoperative mobilisation is crucial for reducing complications such as venous thromboembolism, pneumonia, and prolonged hospital stay.[6]

Similarly, the suprainguinal fascia iliaca compartment block (S-FICB) is a refined variant of the classical FICB, allowing a more cephalad spread of local anaesthetic beneath the fascia iliaca. This results in more consistent blockade of the femoral, lateral femoral cutaneous, and obturator nerves compared to infrainguinal approaches. Multiple studies have reported improved postoperative analgesia, reduced opioid requirements, and better functional outcomes with S-FICB, making it an increasingly preferred choice in multimodal analgesic protocols for hip fractures.[7]

Despite the growing adoption of these techniques, direct comparative evidence evaluating PENG and S-FICB remains limited. Given that both blocks target key components of the hip joint's sensory innervation through different anatomical approaches, determining their relative efficacy is important for optimising perioperative pain management. Moreover, aspects such as ease of positioning for spinal anaesthesia, impact on quadriceps strength, safety profile, and postoperative analgesic requirements continue to be areas of active investigation.

In light of these considerations, the present study seeks to compare ultrasound-guided PENG block and S-FICB in patients undergoing surgery for hip fractures under spinal anaesthesia. The study evaluates not only postoperative analgesic efficacy and opioid consumption but also ease of positioning, time to rescue analgesia, and potential block-related adverse effects. These findings aim to inform clinical practice by identifying the technique that offers superior analgesia, improved patient comfort, and minimal motor impairment in this vulnerable patient population.

MATERIALS AND METHODS

Study Design and Setting

This was a hospital-based, prospective, randomized, double-blind study conducted in the operating theatre complex of Mahatma Gandhi Hospital between September 2022 and March 2024, following approval from the Institutional Ethics Committee.

Participants

Patients aged 18–80 years scheduled for hip surgery under regional anaesthesia were screened for eligibility. Inclusion criteria were ASA physical status I–III and the ability to provide informed consent. Patients with local infection at the block site, allergy to local anaesthetics, coagulopathy, or refusal to participate were excluded.

Randomization and Blinding

Sixty patients were randomly assigned into two groups (n = 30 each) to receive either a pericapsular nerve group (PENG) block or a suprainguinal fascia iliaca compartment block (S-FICB). A computer-generated randomization sequence was used, and group allocation was concealed in sealed opaque envelopes. The anaesthesiologist performing the subarachnoid block and assessing outcomes was blinded to the block technique used.

Block Procedure

All blocks were performed under ultrasound guidance using a Sonosite M-Turbo machine. After standard monitoring and aseptic preparation, the allocated block was performed with 20 mL of 0.5% ropivacaine deposited in the target plane.
After the block, patients were monitored for 30 minutes with continuous ECG, pulse oximetry, and non-invasive blood pressure at 5-minute intervals. Signs of local anaesthetic systemic toxicity were also observed.

Spinal Anaesthesia and Intraoperative Management

Thirty minutes after the block, ease of spinal positioning was assessed using a 4-point Ease of Spinal Positioning (EOSP) scale (0 = unable to position; 3 = optimal positioning). A second anaesthesiologist, blinded to the block received,

performed the spinal anaesthesia in the sitting position using a 25-G Quincke needle and 2.5 mL of 0.5% hyperbaric bupivacaine. No additional analgesics were administered intraoperatively.

Postoperative Analgesia and Follow-up

Pain scores were recorded at rest and during passive 15° limb elevation using the Numeric Rating Scale (0–10) at 4, 6, 8, 12, and 24 hours postoperatively. Rescue analgesia consisted of 100 mg intravenous tramadol, administered when NRS > 4 or on patient demand. The time to first rescue analgesia and total tramadol consumption in 24 hours were documented. Block-related complications were also recorded.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using appropriate statistical tests. Continuous variables were expressed as mean ± SD and compared using the Student's t-test. Categorical variables were compared with the chi-square test. A p-value < 0.05 was considered statistically significant.

RESULTS:

A total of 60 patients were enrolled, with 30 in each study group. The demographic distribution was comparable between groups, with no significant differences in age or sex (Table 1).

Hemodynamic parameters remained stable throughout the study period. Heart rate and oxygen saturation did not differ significantly between groups at any time point (Table 2). Similarly, diastolic blood pressure values were comparable, while systolic blood pressure showed isolated significant differences at 4 hours and 12 hours post-block, though without clinical adverse impact (Table 3).

The ease of spinal positioning was significantly better in the S-FICB group. A greater proportion of S-FICB patients achieved optimal, pain-free positioning (score 3), compared with those receiving PENG, and the mean EOSP score was significantly higher for S-FICB ($p < 0.00001$) (Table 4).

Postoperative pain scores demonstrated consistently lower NRS values in the S-FICB group across all time intervals. At rest and during movement, S-FICB was associated with significantly reduced pain when compared with PENG at 4, 6, 8, 12, and 24 hours (each $p = 0.0001$) (Table 5).

The time to first request for rescue analgesia did not differ significantly between groups ($p = 0.247$), and the total 24-hour tramadol consumption was also comparable ($p = 0.365$), indicating similar overall postoperative analgesic requirements (Tables 6 and 7).

Table 1. Demographic Characteristics of Study Participants

Variable	Category	PENG (n=30)	S-FICB (n=30)	p-value
	31–40	3 (10%)	0 (0%)	
	41–50	4 (13.3%)	8 (26.7%)	
	51–60	9 (30%)	8 (26.7%)	
	61–70	8 (26.7%)	9 (30%)	
Age (years)	71–80	6 (20%)	5 (16.7%)	0.19
	Male	13 (43.3%)	19 (63.3%)	
Sex	Female	17 (56.7%)	11 (36.7%)	0.12

Table 2. Hemodynamic Parameters (HR and SPO2)

Timepoint	HR (bpm) PENG	HR S-FICB	P value	SpO_2 (%) PENG	SpO_2 S-FICB	P value
Pre-block	80.8±15	88.1±8.9	0.08	99.3±0.86	99.3±0.75	0.96
30 min post	88.3±13.2	91.4±13.3	0.06	99.1±0.93	99.3±0.71	0.97
4 hr	85.8±11.4	90.3±6.75	0.64	99.1±0.86	98.75±0.92	0.93
6 hr	92.9±5.9	92.3±6.4	0.89	98.6±0.92	98.8±0.83	0.98
8 hr	91.1±6.9	90.6±7	0.91	98.7±0.90	98.8±0.99	0.94
12 hr	89.9±7.8	85.5±10	0.57	99±0.89	98.8±1.01	0.89
24 hr	91.5±6.4	90.6±6.6	0.82	98.9±0.89	98.74±0.85	0.92

Table 3. Hemodynamic Parameters (HR and SBP)

Timepoint	DBP (mmHg) PENG	DBP S-FICB	P value	SBP(mmHg) PENG	SBP S-FICB	P value
Pre-block	83.8±10.9	82.8±9.2	0.87	138.5±20.7	132±20.1	0.31
30 min post	78.9±8.2	77.8±9.1	0.79	131.7±19.8	128.7±16.9	0.69
4 hr	82.8±9.2	80.8±8.6	0.31	127.8±16.8	132±10.8	0.001**
6 hr	82.1±8.1	81.7±8.3	0.87	128.8±16.5	121.7±20.4	0.95
8 hr	78.9±8.2	79.5±8.5	0.92	136±19.6	131.4±17.9	0.2
12 hr	79.5±8.5	79.6±8.7	0.99	135.5±19.2	126.6±18.2	0.02*
24 hr	79.45±8.3	79.4±8.2	0.99	128.5±17.1	126±18.1	0.82

Table 4. Ease of Spinal Positioning (EOSP)

EOSP Score	Meaning	PENG (n=30)	S-FICB (n=30)
0	Unable to position	0	0
1	Abnormal posture; requires support	6	1
2	Mild discomfort, no support needed	20	3
3	Optimal, pain-free positioning	4	26
Mean ± SD	—	**1.92 ± 0.69**	**2.98 ± 0.91**
p-value	—	<0.00001**	

Table 5: Mean Post-operative NRS Scores (Block-wise)

Time	PENG – Rest	S-FICB– Rest	P value	S-FICB – Movement	PENG – Movement	P value
4 hr	3.62	2.73	0.0001**	3.38	4.9	0.0001**
6 hr	3.64	2.74	0.0001**	3.38	4.83	0.0001**
8 hr	3.64	2.73	0.0001**	3.38	4.7	0.0001**
12 hr	3.67	2.75	0.0001**	3.33	4.6	0.0001**
24 hr	3.5	2.75	0.0001**	3.33	4.61	0.0001**

Table 6: Time to First Rescue Analgesia

Group	Mean Duration (min)	SD	p-value
PENG	312.4	53.38	
S-FICB	321.9	56.37	0.247

Table 7: Total Rescue Analgesic Consumption (24 hrs)

Group	Mean Tramadol Dose (mg)	SD	p-value
PENG	180 mg	11.45	
S-FICB	185 mg	12.34	0.365

DISCUSSION:

This randomized, double-blind study compared the analgesic efficacy and perioperative performance of the pericapsular nerve group (PENG) block and the suprainguinal fascia iliaca compartment block (S-FICB) in patients undergoing hip surgery under spinal anaesthesia. The findings demonstrate that while both techniques offer effective analgesia, S-FICB provides significantly superior outcomes in terms of ease of positioning for spinal anaesthesia and postoperative pain relief.

The demographic characteristics of both groups were comparable, minimizing confounding influences related to age or sex distribution. Hemodynamic stability observed across all time intervals further indicates that both blocks are safe and well-tolerated, with no clinically significant deviations in heart rate, blood pressure, or oxygen saturation. This aligns with existing literature by Shariat et al.[7] and Vermeylen et al.[8], highlighting the favorable safety profiles of both approaches.

One of the most clinically relevant findings of this study is the markedly better ease of spinal positioning observed in patients receiving S-FICB. Nearly 87% of these patients achieved optimal, pain-free positioning (EOSP score 3), compared to only 13% in the PENG group. While earlier studies have suggested PENG may offer motor-sparing benefits due to its focused action on articular branches, our results indicate that, in the context of pre-spinal positioning for hip fracture surgery, S-FICB may offer a more comprehensive sensory blockade that translates into more comfortable

positioning. These findings support previous evidence suggesting that S-FICB provides broader spread under the fascia iliaca and more consistent blockade of the femoral, obturator, and lateral femoral cutaneous nerves.

Postoperative pain scores were consistently lower in the S-FICB group at all measured intervals up to 24 hours. This was evident both at rest and during passive movement, with a highly significant difference between groups ($p = 0.0001$ at every time point). This reinforces the hypothesis that the cranial spread of local anaesthetic achieved with S-FICB allows for a more complete analgesic effect on the anterior hip capsule, the primary source of nociception in hip fractures. Although several earlier studies have reported comparable analgesic efficacy between PENG and S-FICB, Jadon et al.[9] observed reduction in NRS at rest as well on movement at 4,6,12,24 hours. In PENG group, NRS was significantly lower in 24 hours. At all other time intervals, NRS was non-significant in their study. Bauiomy et al.[10] stated that, although NRS post-operatively was lower in PENG group then S-FICB group at 2,4,8,12,24 hours but results were statistically insignificant. Our findings are in agreement with reports demonstrating improved pain outcomes with S-FICB, particularly in the immediate postoperative period.

Despite these differences in pain scores, the time to first rescue analgesia and the total tramadol consumption over 24 hours were similar between groups. This suggests that while S-FICB provides superior early and dynamic analgesia, both blocks are effective in providing sufficient overall postoperative pain control within a multimodal regimen. These results echo findings from previous comparative studies where block-related differences in pain intensity did not necessarily correspond to differences in opioid consumption, possibly due to standardized rescue protocols or ceiling analgesic effects. Bauiomy et al. [10] stated that mean time (in hours) to first rescue analgesic in S-FICB was 8.58 and in PENG 8.93. The result of rescue analgesic request was not significantly different between both the groups ($p = 0.552$). Tang et al.[11] said that there was no statistically significant difference in the number of rescue analgesics at 0-12 h or 12-24 h

The clinical implications of these findings are notable. First, improved ease of spinal positioning can enhance procedural efficiency, reduce patient distress, and potentially mitigate perioperative cardiovascular stress an important consideration in elderly and frail hip fracture patients. Second, superior early analgesia with S-FICB may facilitate better patient cooperation, smoother recovery, and earlier initiation of rehabilitation. Given current emphasis on fast-track orthopaedic pathways, these advantages could contribute to better functional outcomes and reduced hospital stays.

However, it is important to contextualize these findings within the evolving understanding of PENG block anatomy. Recent imaging studies suggest that PENG may primarily affect branches within the iliopsoas muscle rather than reliably reaching articular branches of the hip capsule. This anatomical variability may explain inconsistencies in analgesic performance reported across studies and observed in our results.

CONCLUSION:

In summary, S-FICB demonstrated superior ease of spinal positioning and significantly better postoperative pain relief compared to PENG block in patients undergoing hip surgery. Both techniques were safe and resulted in comparable opioid consumption. Based on these findings, S-FICB may be preferred when optimal positioning and enhanced early analgesia are clinical priorities. Further research with larger samples and mechanistic imaging studies may help clarify the precise role of PENG in perioperative hip analgesia and refine patient selection for each block.

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