Original Article

PENG Block: A superior alternative for pain management in intracapsular hip fractures

ABSTRACT

Background and Objectives: Previous studies have demonstrated the effectiveness of regional analgesic techniques for pain management after hip surgery; however, no clear superiority between these techniques has been established. A key limitation of these studies is the lack of differentiation between fracture subtypes. This prospective, comparative cohort study aims to evaluate the effectiveness of two regional techniques—pericapsular nerve group block (PENG) and suprainguinal iliac fascia block (FICB)—in providing perisurgical analgesia for intracapsular femoral fractures.

Materials and Methods: Sixty-four patients undergoing elective surgery for intracapsular femoral fractures were randomly assigned to receive either a PENG block or an FICB block, each with 15 mL of 0.2% ropivacaine. Intradural anesthesia and conventional intravenous analgesia were administered during surgery. The primary outcome was pain scores in the recovery room and 24 hours post-surgery. Secondary outcomes included the need for intravenous opioid rescue medication during the first 24 hours.

Results: The PENG group demonstrated significantly lower postoperative pain scores compared to the FICB group both immediately after surgery ($P = 0.006$) and at 24 hours ($P < 0.001$). Additionally, fewer patients in the PENG group required weak opioids in the first 24 hours following surgery ($P = 0.001$).

Conclusions: The PENG block provides superior postoperative analgesia for intracapsular femoral fractures compared to the FICB block following hip surgery, with reduced opioid consumption observed in the PENG group.

Clinical Trial Registration: NCT05377541.

Key words: Hip fractures, pain, PENG block, regional anesthesia

Introduction

Hip fractures are common among elderly patients and are associated with significant morbidity and mortality. These fractures are classified as either intracapsular or extracapsular based on their location relative to the articular capsule of the femoral head. Intracapsular fractures affect the femoral neck and are further divided into capital, subcapital, transcervical, and basicervical types. Extracapsular fractures involve the trochanteric

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region and include pertrochanteric and subtrochanteric fractures.[1,2]

Intrathecal anesthesia is the standard approach for these surgeries, but various peripheral regional blocks have gained attention in recent years as alternative methods for perioperative pain management. Techniques such as the three-in-one block, femoral nerve block, and suprainguinal iliac fascia block (FICB) have been shown to reduce opioid consumption and minimize adverse effects like postoperative delirium.[3-10]

The anterior portion of the hip joint contains a high density of sensory and mechanoreceptor fibers, innervated by the femoral, obturator, and obturator accessory nerves. The pericapsular nerve group (PENG) block, a newly described technique, targets these innervations for pain management in proximal femoral surgery. Initially introduced for managing acute pain from femoral fractures, the PENG block has since been expanded for broader use. Its mechanism involves blocking the articular branches of the femoral, obturator, and obturator accessory nerves, located at the depth of the psoas tendon, between the iliopubic eminence and the inferior iliac spine.[11-14]

In comparison, the FICB is a non-selective block affecting the femoral, lateral femoral cutaneous, and obturator nerves. While FICB is commonly used for hip fracture analgesia, the PENG block is likely to offer superior pain relief due to its high selectivity. Both are peripheral techniques that do not impact hemodynamic stability.

While several case series and comparative studies have evaluated the effectiveness of different nerve blocks, no definitive conclusion has been reached regarding the superiority of one technique over the other.[15-22] Many of these studies suffer from limitations such as large anesthetic volumes or failure to differentiate fracture types, which may influence outcomes and obscure statistically significant differences.

This study aimed to compare the effectiveness of PENG and FICB blocks in managing postoperative pain following hip surgery for intracapsular femoral fractures. We hypothesized that patients receiving the PENG block would experience less pain than those receiving the FICB block.

Methods

Study design and patient enrollment

This prospective, comparative cohort study was conducted at Consorci Sanitari de Terrassa hospital between April 29, 2022, and March 26, 2023. Ethical approval was obtained from the Ethical Research Committee of Consorci Sanitari de Terrassa on April 25, 2022 (01-22-270-037), and the study was registered on ClinicalTrials.gov (NCT05377541) on May 5, 2022. All participants provided written informed consent before enrollment. The first patient was enrolled on May 29, 2022.

A total of 68 adult patients scheduled for elective surgery for intracapsular femoral fractures were recruited. Exclusion criteria included: (i) cognitive impairment, (ii) pre-existing sensory or motor deficits, (iii) multiple fractures, (iv) anticoagulant or antiplatelet therapy, (v) chronic pain treatment, (vi) hemodynamic instability, (vii) refusal to participate or failure to provide informed consent, and (viii) age below 18 years. Patients were randomly assigned to one of two groups: the PENG block group or the FICB group.

Study intervention

Upon arrival in the operating room, peripheral venous access was established. Standard monitoring, including non-invasive blood pressure, electrocardiography, and pulse oximetry, was implemented. The nerve blocks were administered with patients in the supine position, before the surgical procedure.

PENG block technique

A low-frequency curvilinear convex ultrasound probe (2–5 MHz; SonoSite SII; SonoSite Inc., Madrid, Spain) was positioned transversely over the anteroinferior iliac spine and then rotated 45° to visualize the psoas tendon and iliopubic eminence [Figure 1]. A 22-gauge, 100 mm echogenic needle (Echoplex+; Vygon, Paterna, Spain) was inserted in an in-plane approach from lateral to medial until the needle tip was located between the psoas tendon and pubic ramus. After negative aspiration, 15 mL of 0.2% ropivacaine was injected, ensuring elevation of the psoas tendon.

FICB technique

A linear ultrasound probe (2 MHz–5 MHz; SonoSite SII; SonoSite Inc., Madrid, Spain) was positioned at the junction of the middle and lateral thirds of the inguinal ligament in a parasagittal orientation. The sartorius, internal oblique, and iliacus muscles were identified. A 22-gauge, 50 mm echogenic needle (Echoplex+; Vygon, Paterna, Spain) was inserted using an in-plane approach in a caudal-to-cephalad direction [Figure 2]. Once the needle tip was positioned above the iliacus muscle and below the fascia, 15 mL of 0.2% ropivacaine was injected following negative aspiration, confirming the separation of the two structures.

Perioperative management

After the regional blocks were performed under sterile

conditions, all patients received spinal anesthesia at the L3-L4 level using a 25G Whitacre needle. A total of 8 mg–10 mg of isobaric 0.5% bupivacaine and 10 mcg of fentanyl were administered. Intravenous analgesia consisted of 1 g of paracetamol, 1.2 g of metamizole, and 2 g of cefazolin.

In the post-anesthesia care unit, patients reporting pain (VNRS ≥3) received an initial rescue dose of tramadol (1 mg/kg). If pain persisted, a second rescue dose of morphine (3 mg) was administered. The postoperative analgesic regimen for the first 24 hours included IV paracetamol (1 g every 8 hours) and IV metamizole (1.2 g every 8 hours). Rescue analgesia was provided with IV tramadol (1 mg/kg every 8 hours) and IV morphine (3 mg every 8 hours) if needed. Rescue antiemetics were administered for nausea or vomiting. Early rehabilitation exercises were encouraged within the first 24 hours postoperatively.

Outcome measures

Demographic data, including age, sex, ASA score, BMI, fracture type, and surgical intervention, were recorded. The primary outcome was postoperative pain intensity at 0 and 24 hours, assessed using the 0–10 VNRS. Spinal block reversal was confirmed through cold sensitivity tests and the Bromage scale for motor function assessment. The need for rescue analgesia (tramadol or morphine) during the first 24 hours was also recorded.

Statistical analysis

Descriptive statistics were used to summarize categorical variables as percentages with confidence intervals. Continuous variables were expressed as medians with interquartile ranges. Group comparisons were performed using Chi^2 and Fisher's exact tests for categorical variables and the Mann-Whitney U test or Student's *t*-test for continuous variables, depending on data distribution (assessed with the Shapiro-Wilk test). All statistical tests were two-tailed, with an alpha risk of 0.05. A P value < 0.05 was considered statistically significant.

Sample size calculations were based on an alpha risk of 0.05 and a beta risk of 0.8. Assuming a minimum difference of two points on the VNRS with a standard deviation of 2.5 and an expected 20% attrition rate, at least 31 patients per group were required.

Results

A total of 68 patients met the inclusion criteria and were enrolled in the study, with 34 patients assigned to each group. No participants withdrew during the study period. The demographic characteristics of both groups were comparable, with no statistically significant differences that could impact the outcomes [Table 1].

Table 1: Demographic characteristics of the two groups

	PENG group (n=34)	FICB group (n=34)	*P*
Gender			0.622
Female	19 (55.9)	21 (61.8)	
Male	15 (44.1)	13 (38.2)	
Age (years)			0.613
<65 years	3 (8.8)	1 (2.9)	
	31 (91.2)	33 (97.1)	
ASA			0.770
I - II	8 (23.5)	7 (20.6)	
III - IV	26 (76.5)	27 (79.4)	
Laterality of the fracture			0.806
Right	15 (44.1)	14 (41.2)	
Left	19 (55.9)	20 (58.8)	
Type of surgery			0.177
Arthroplasty/Hemiarthroplasty	22 (64.7)	27 (79.4)	
DHS/Gamma	12 (35.3)	7 (20.6)	

Values presented as frequency (%). PENG=pericapsular nerve group block, FICB=suprainguinal iliac fascia block, ASA=American Society of Anesthesiologists

Patients in the PENG group experienced significantly lower postoperative pain scores than those in the FICB group, both immediately after surgery ($P = 0.006$) and at 24 hours postoperatively ($P < 0.001$). The risk of experiencing pain immediately after surgery was 2.83 times higher (95% CI: 1.27–6.31) in the FICB group. At 24 hours, the likelihood of experiencing moderate or severe pain (VNRS > 3) was 3.25 times higher (95% CI: 1.18–8.97) in the FICB group. Furthermore, pain intensity was significantly lower in the PENG group, with a trend toward milder pain immediately post-surgery ($P = 0.01$) and at 24 hours ($P = 0.001$). Regarding rescue analgesia requirements, the FICB group had a significantly higher need for initial opioid administration within the first 24 hours ($P = 0.001$). The risk of requiring opioid analgesia was 2.75 times higher (95% CI: 1.43–5.29) in the FICB group compared to the PENG group. However, no statistically significant differences were observed in the requirement for a second opioid rescue dose [Table 2].

Discussion

Our study demonstrated that patients receiving the PENG block reported lower pain scores 24 hours post-surgery and required fewer opioids in the first 24 hours compared to those receiving the FICB block. These findings suggest that the PENG block may provide more effective postoperative analgesia, likely due to differences in the innervation of the femur based on the fracture site.

Table 2: Analgesic outcomes and opioid consumption results

	PENG group ($n=34$)	FICB group ($n=34$)	P*
Pain at the recovery room	0 (0–0)	0.5 (0–2)	0.006
Pain intensity at the recovery room[a]			0.010
No pain	28 (82.4)	17 (50.0)	
Mild pain	6 (17.6)	16 (47.1)	
Moderate pain	0 (0.0)	1 (2.9)	
RR PENG/FICB[b]	2.83 (1.27–6.31)		
Pain at 24 hours	1.5 (0.25–3)	3 (2–4)	<0.001
Pain intensity at 24 hours[a]			0.001
No pain	9 (26.5)	0 (0.0)	
Mild pain	21 (61.8)	21 (61.8)	
Moderate pain	4 (11.8)	12 (35.3)	
Severe pain	0 (0.0)	1 (2.9)	
RR PENG/FICB[c]	3.25 (1.18–8.97)		
Need of tramadol rescue			0.001
No	26 (76.5)	12 (35.3)	
Yes	8 (23.5)	22 (64.7)	
RR PENG/FICB[d]	2.75 (1.43–5.29)		
Need of morphine rescue			0.356
No	33 (97.1)	30 (88.2)	
Yes	1 (2.9)	4 (11.8)	

Values presented as median (IQR) and frequency (%). Pain is evaluated with a 0–10 Verbal Numerical Rate Score (VNRS). RR=relative risk, PENG=pericapsular nerve group block, FICB=suprainguinal iliac fascia block. *Significant at 0.05 level for analysis of variance. [a]No pain=0; Mild pain=1–3; Moderate pain=4–6; Severe pain=7–10. [b]Relative risk of having pain. [c]Relative risk of having moderate or severe pain. [d]Relative pain of needing analgesic rescue

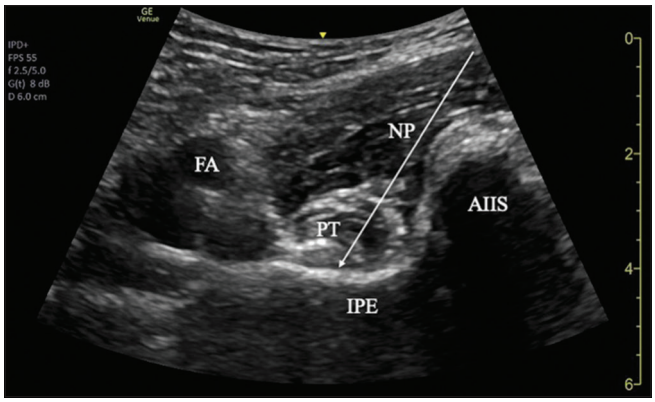

Figure 1: Ultrasound image of the pericapsular nerve group block: NP = Needle path, IPE = Iliopubic eminence, FA = Femoral artery, PT = Psoas tendon, AIIS = Anterior inferior iliac spine

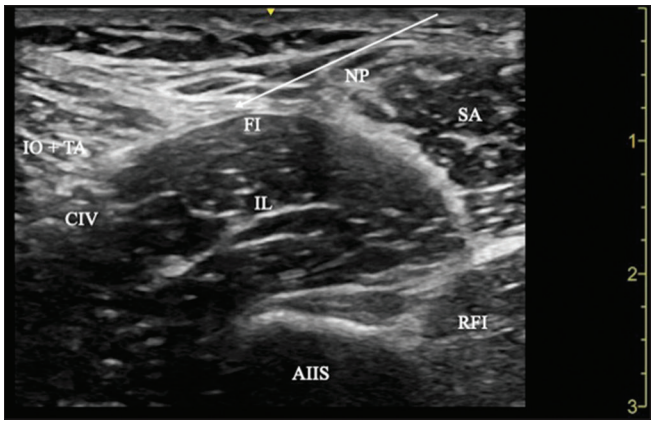

Figure 2: Ultrasound image of the suprainguinal iliac fascia block: NP = Needle path, FI = Fascia iliaca, IL = Iliopsoas, SA = Sartorius, RFI = Rectus femoralis insertion, CIV = Circumflex iliac vessels, IO + TA = Internal oblique and transversus abdominus muscles

A major strength of this study is its focus on intracapsular femoral fractures specifically. The anterior hip capsule, which contains the highest concentration of sensory and mechanoreceptor fibers, is innervated by the femoral, obturator, and obturator accessory nerves.[11,12] The PENG block precisely targets these nerves, which may explain its superior analgesic effect. In contrast, other regional techniques, including the FICB, provide a non-selective block of the femoral, lateral femoral cutaneous, and obturator nerves. Additionally, some previous studies suggest that the analgesic effect of femoral nerve blocks may be partly due to quadriceps muscle relaxation rather than direct sensory blockade.[23]

There is a general consensus that regional blocks are recommended for patients undergoing total hip arthroplasty.[24] Over time, various locoregional techniques have emerged to optimize perioperative pain control in hip surgeries and proximal femoral fractures.[5-10] Among these, PENG and FICB blocks have gained prominence. Despite numerous comparative studies, results remain inconclusive regarding the superior technique. While some studies indicate that patients receiving the PENG block require fewer opioids in the first 24 hours, differences in pain intensity between the two techniques are often unclear.[25-27] We believe that two key factors may have influenced the inconsistent findings in

previous studies: (i) failure to differentiate between fracture types, and (ii) variations in anesthetic volume administration.

This study is among the largest published to date and benefits from standardized anesthetic volume administration to minimize variability. However, some limitations should be acknowledged. First, we analyzed only mean pain scores without distinguishing between pain at rest and during movement. Additionally, pain assessment at 6 and 12 hours postoperatively was not included, which could have provided further insights into pain progression. Another limitation inherent in prospective studies is the lack of randomization. Moreover, neither patients nor clinicians were blinded to group allocation, which may have introduced performance and detection biases.

Despite these limitations, our findings provide valuable guidance for clinicians selecting the most effective analgesic strategies for hip fractures. Effective postoperative pain management, reduced opioid consumption, and early mobility are associated with shorter hospital stays and faster recovery. These factors are particularly relevant for elderly and frail populations, where any additional complications can significantly increase morbidity and mortality.

In conclusion, the PENG block offers superior postoperative analgesia compared to the FICB block for intracapsular femoral fractures following hip surgery. Patients receiving the PENG block experienced lower pain intensity and reduced opioid consumption, making it a preferable option for pain management in this patient population.

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Conflicts of interest
There are no conflicts of interest.

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