ORIGINAL ARTICLE

Comparison of the perioperative efficacy of pericapsular nerve group (PENG) block and the suprainguinal fascia iliaca compartment block (S-FICB) in patients undergoing hip fracture surgery: Spinal positioning, medication usage, and patient satisfaction

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ABSTRACT

BACKGROUND: This study aimed to compare the effects of pericapsular nerve group (PENG) block and suprainguinal fascia iliaca compartment block (S-FICB) on perioperative pain control in patients undergoing surgery for intertrochanteric femoral fractures.

METHODS: Patients who underwent surgery for intertrochanteric femoral fractures between June 2021 and June 2024 were retrospectively analyzed. The study included patients who underwent surgery for intertrochanteric femoral fractures using a proximal femoral nail under spinal anesthesia, combined with either a PENG block or an S-FICB. The patients were divided into two groups: those who underwent a PENG block were assigned to Group I, and those who received an S-FICB were assigned to Group II. Functional assessments included perioperative numerical rating scale (NRS) scores, the timing and amount of systemic analgesics use, patient satisfaction, nausea, vomiting, and motor muscle strength.

RESULTS: The spinal positioning score was significantly better in Group I ($p<0.01$). NRS scores were significantly lower in Group I at the 6th and 12th hours during exercise ($p<0.001$). Patient satisfaction scores were also significantly higher in Group I ($p=0.04$). The time to first opioid use was earlier, and the total opioid dose was higher, in Group II ($p=0.03$ and $p=0.04$, respectively).

CONCLUSION: The PENG block, with its more potent analgesic effect, easier positioning, lower opioid consumption, and higher patient satisfaction, emerges as a promising option for hip fracture surgery.

Keywords: Pericapsular nerve group; suprainguinal fascia iliaca block; ease of spinal positioning; analgesia; spinal anesthesia; hip fracture.

INTRODUCTION

Hip and proximal femur fractures in the elderly can result from low-energy trauma due to osteoporotic changes and contribute significantly to increased morbidity and mortality.[1,2] As hip surgeries are often associated with severe perioperative pain, multimodal analgesia is commonly used in perioperative pain management, involving a combination of various pharmacological agents along with central and peripheral nerve blocks.[3] The elderly population, along with their multiple comorbidities, difficulties in pain management, and increased sensitivity to delirium and sedation, makes perioperative management even more difficult.[4] However, since

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opioids frequently cause complications, such as nausea, vomiting, delirium, constipation, and respiratory depression, the use of regional anesthetic techniques is increasingly favored.[5] To manage pain following hip surgery, techniques such as femoral nerve block, sciatic nerve block, psoas compartment block, pericapsular nerve group block (PENG), fascia iliaca compartment block, and suprainguinal fascia iliaca compartment block (S-FICB) are commonly employed.[1,6]

The fibers of the femoral nerve, obturator nerve, and accessory obturator nerve innervate the hip joint and can become vulnerable and painful in cases of fracture or arthrosis.[7] Early surgical treatment (within 48 hours) and early mobilization are generally recommended to reduce perioperative morbidity.[2,8] Both S-FICB and PENG blocks can be used safely for these purposes.[7,9,10] The PENG block may offer particular advantages, as it targets the obturator nerve, accessory obturator nerve, and branches of the femoral nerve that innervate the anterior hip capsule, without causing lower limb weakness that could hinder mobilization.[7,9]

Most previous studies have focused on the effectiveness of these blocks in terms of exercise-related outcomes, postoperative analgesia, or preoperative positioning in patients undergoing total hip arthroplasty. In our study, we investigated the effects of PENG and S-FICB blocks, administered in addition to spinal anesthesia, on positioning pain, opioid consumption during the first 24 hours postoperatively, pain scores, patient satisfaction, motor muscle strength loss, and the incidence of perioperative complications.

MATERIALS AND METHODS

Patient Selection and Study Design

Ethical approval was obtained from the authors' affiliated institution (KAEK-317238). Verbal and written informed consent was obtained from all patients who underwent surgery and agreed to the block procedure. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee, as well as the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

This study included patients who underwent surgery for intertrochanteric femur fractures between June 2021 and June 2024. Eligible participants were individuals aged over 18 and under 90 years who received spinal anesthesia for surgical treatment of hip fractures. The following exclusion criteria were applied:

1. History of previous surgical intervention on the same hip or surgery for any other indication.
2. Requirement of general anesthesia at any stage of the procedure.
3. Presence of coxarthrosis or neurological deficits affecting the lower extremities.
4. Fractures resulting from pathological bone disease.
5. Incomplete or insufficient medical records.
6. An American Society of Anesthesiologists (ASA) score greater than III.

Preoperative data such as the mechanism of injury and the time between trauma and surgery were obtained from patients' medical records (Fig. 1).

For all patients who underwent hip fracture surgery, a standardized form was completed by an independent observer who was not involved in the anesthetic or surgical procedures in the operating theatre or in inpatient follow-up care. This form included information on pain levels, ease of spinal positioning (EOSP), and medication dosage. These forms were later retrospectively reviewed and analyzed. Patients who received the PENG block were assigned to Group I, and those who received the S-FICB were assigned to Group II.

Block and Surgical Procedure

Patients were transported to the operating room, where standard monitoring was applied, including electrocardiography (ECG), non-invasive blood pressure measurement, and pulse oximetry. Pre-procedure pain was assessed with the patient in a supine position using the Numeric Rating Scale (NRS) [0=no pain; 10=worst imaginable pain]. All blocks were performed by a single anesthesiology specialist (A.G.) with the patient in a supine position and under strict sterile conditions. Both block types were administered using standard, previously described techniques (Fig. 1).

After the block was administered, patients underwent continuous monitoring, including non-invasive blood pressure measurements every 5 minutes, along with continuous ECG and pulse oximetry. They were observed for signs of local anesthetic toxicity for a duration of 30 minutes.

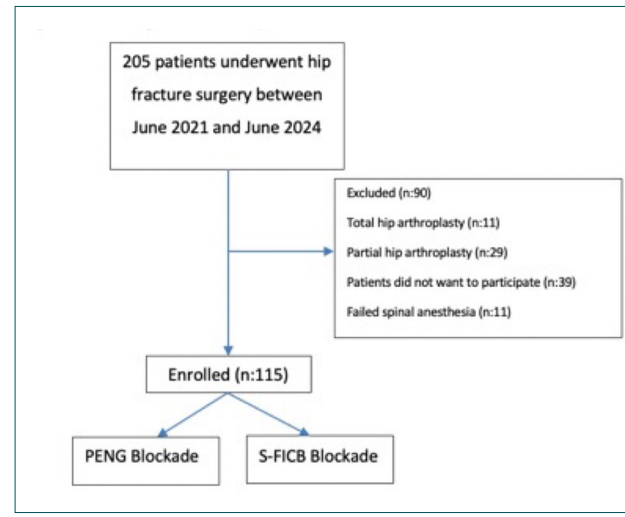

Figure 1. Flowchart of patient selection based on the study's inclusion and exclusion criteria. PENG: Pericapsular nerve group; S-FICB: Suprainguinal fascia iliaca compartment block.

Thirty minutes after the administration of the block, analgesia was assessed using the NRS at rest and during passive limb elevation. If a patient's NRS exceeded 5, intravenous (IV) fentanyl (20 µg) was administered every five minutes until the NRS score was reduced to 3 or below, at which point the patient was allowed to assume a sitting position for spinal anesthesia (SA). The pain associated with spinal positioning was evaluated on a scale of 0 to 3:

- 0: Unable to position;
- 1: Abnormal posturing due to pain, requiring support;
- 2: Mild discomfort, no support required;
- 3: Optimal condition, able to position independently without pain.

All operations were performed at a single center by one surgeon (M.G.) with five years of experience in trauma surgery. With the patient in a supine position and under strict sterile technique, closed reduction was performed primarily. Following confirmation of fracture reduction via fluoroscopy, an oblique incision was made 5 cm superior to the upper extremity of the greater trochanter, and the initial access tunnel was established. All patients were treated using the PFNA Simplelock proximal femoral nailing device (Zimed, Gaziantep, Türkiye).

Postoperative Follow-Up Procedure

After surgery, patients received 1 g of intravenous paracetamol every six hours as routine analgesia (not administered if the NRS was ≤2 and the patient did not request it). If the NRS was ≥4, 75 mg of diclofenac was administered intramuscularly as a rescue analgesic. If the NRS remained ≥4 after diclofenac administration, 50 mg of intravenous tramadol was given as a secondary rescue analgesic. The time to first rescue analgesia (i.e., the interval from discharge from the operating theater to the administration of the first dose of rescue medication) and the total analgesic demand (i.e., the number of rescue analgesic doses administered) were recorded.

Postoperatively, patients were mobilized with double crutches once the motor blockade in the lower extremities had resolved. All patients were discharged without additional complications following a wound check conducted at least 24 hours after surgery.

Statistical Analysis

The normality of data distribution was assessed using the Kolmogorov-Smirnov test for a random sample. Qualitative data were presented as numbers and percentages; normally distributed quantitative data were expressed as mean ± standard deviation, and non-normally distributed quantitative data as median (minimum-maximum). The chi-square test was used for comparisons between groups for qualitative variables. For quantitative data, the Student's t-test was used when the data followed a normal distribution; otherwise, the Mann-Whitney U test was applied. The Statistical Package for the Social Sciences (Version 20.0, SPSS Inc., Chicago, IL, USA) was used for data analysis. Statistical significance was set at $p<0.05$ for all analyses.

The primary outcome was pain intensity, measured using the Numerical Rating Scale (0=no pain, 10=worst possible pain), assessed before spinal positioning and at 1, 3, 6, 9, 12, 15, 18, 21, and 24 hours postoperatively. Secondary outcomes included the time to systemic analgesic consumption, total dose of systemic analgesics administered, motor muscle strength, patient satisfaction, and any observed complications.

A post hoc power analysis revealed that the statistical power to detect differences in ease of spinal positioning between the two groups (with 56 patients per group) exceeded 0.95. An effect size of f=0.528 confirmed that the sample size was sufficient to detect between-group differences.[11]

Table 1. Demographic characteristics of patients

	PENG Block	S-FICB	p
Age (years): mean±SD	75.08±8.53	71.91±10.23	0.37[a]
Gender (F-M): n (%)	27-32 (46-54)	29-27 (52-48)	0.52[c]
BMI (kg/m2): mean±SD	28.73±3.91	28.81±3.07	0.21[a]
ASA (II/III): n (%)	10-49 (17-83)	15-41 (27-73)	0.20[c]
No comorbidities: n (%)	9 (15)	12 (21)	0.47[c]
Hypertension (yes): n (%)	32 (54)	29 (52)	0.85[c]
Diabetes mellitus (yes): n (%)	14 (24)	16 (29)	0.67[c]
Cardiac disease (yes): n (%)	13 (22)	8 (14)	0.34[c]
Chronic lung disease (yes): n (%)	14 (24)	10 (18)	0.49[c]

[a]Student's t-test; [b]Mann-Whitney U test; [c]Chi-square test; F: Female; M: Male; BMI: Body Mass Index; ASA: American Society of Anesthesiologists; PENG: Pericapsular nerve group; S-FICB: Suprainguinal fascia iliaca compartment block.

RESULTS

A total of 205 patients underwent surgical intervention for hip fractures during the study period. Ninety patients were excluded from the study due to the need for general anesthesia during surgery, undergoing total or bipolar hip arthroplasty, or having sufficient data. A detailed study flowchart is presented in Figure 2. The mean age of the patients was 73.5±9.3 years. A balanced representation of both genders was achieved, with 56 female and 59 male participants. There were no statistically significant differences in patient demographics between the groups. Table 1 provides an overview of the patient characteristics.

Functional Results

During the positioning phase prior to spinal anesthesia, analysis of the NRS scores revealed that while pain levels were low in both groups, the score was significantly lower in Group I (2.88±1.38) compared to Group II (3.48±1.11; p=0.01) (Table 2).

In the postoperative recovery room, both groups demonstrated significant pain reduction at rest and during movement, with no statistically significant differences between them (p=0.95 for both) (Table 2).

Analysis of postoperative NRS scores revealed that signifi-

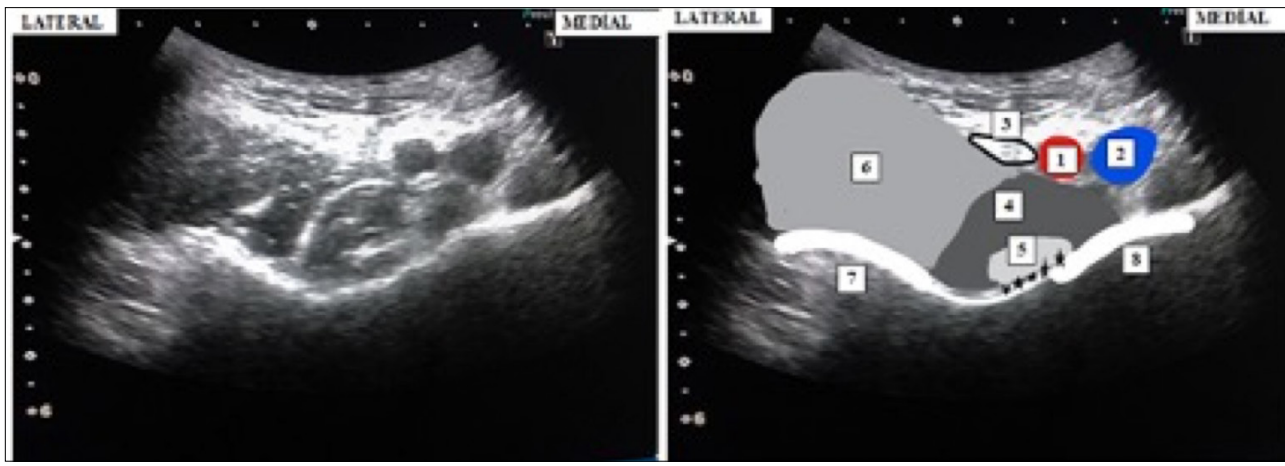

Figure 2. Application of the pericapsular nerve group (PENG) block under ultrasound guidance, femoral artery. 2: Femoral vein; 3: Femoral nerve; 4: Psoas muscle; 5: Psoas tendon; 6: Iliac muscle; 7: Spina iliaca antero-inferior; 8: Iliopubic eminence; *: Area where the local anesthetic agent is administered.

Table 2. Comparison of perioperative pain scores at rest and during movement between block groups

	PENG Block	S-FICB	p
NRS pre-spinal positioning	2.88±1.38	3.48±1.11	0.01[a*]
rNRS - Recovery room	0.24±0.43	0.23±0.43	0.95[a]
mNRS - Recovery room	0.47±0.86	0.46±0.85	0.95[a]
rNRS - Postoperative 3rd hour	0.59±0.67	0.57±0.71	0.87[a]
mNRS - Postoperative 3rd hour	1.25±1.18	1.48±1.08	0.28[a]
rNRS - Postoperative 6th hour	0.66±0.73	1.8±0.67	0.28[a]
mNRS - Postoperative 6th hour	1.98±0.96	2.21±1.06	0.01[a]
rNRS - Postoperative 12th hour	1.71±0.83	1.86±0.77	0.33[a]
mNRS - Postoperative 12th hour	2.32±1.06	3.7±1.22	0.04[a]
rNRS - Postoperative 18th hour	1.56±0.75	1.63±0.75	0.64[a]
mNRS - Postoperative 18th hour	3.17±0.79	3.38±0.84	0.18[a]
rNRS - Postoperative 24th hour	1.32±0.57	1.38±0.62	0.63[a]
mNRS - Postoperative 24th hour	2.66±0.66	2.82±0.61	0.18[a]

[a]Student's t-test; *Statistically significant. Quantitative data are presented as mean ± standard deviation. PENG: Pericapsular nerve group; S-FICB: Suprainguinal fascia iliaca compartment block; rNRS: Numerical Rating Scale at rest; mNRS: Numerical Rating Scale during movement.

Table 3. Comparison of perioperative patient outcomes between block groups

	PENG Block	S-FICB	p
Patient satisfaction score	7.8±1.24	7.27±1.46	0.04[a*]
Surgical duration (minutes)	107.71±17	105.27±11.34	0.37[a]
Time to first opioid use (hours)	15.67±3.45	11.71±2.24	0.03[a]
Total postoperative opioid consumption (mg of tramadol hydrochloride)	44.07±51.77	58.04±47.46	0.04[a]
Motor block duration (hours)	2.36±1.16	3.16±1.5	0.002[a*]
Postoperative nausea (yes): n (%)	7 (12)	16 (29)	0.03b*
Postoperative vomiting (yes): n (%)	2 (3)	8 (14)	0.04[b*]
Length of hospital stay (days)	2.66±1.03	2.89±0.97	0.22[a]

[a]Student's t-test; bChi-square test; *Statistically significant. Quantitative data are presented as mean ± standard deviation. PENG: Pericapsular nerve group; S-FICB: Suprainguinal fascia iliaca compartment block.

cant pain control was achieved in both groups. However, the effectiveness of the nerve blocks diminished after the 12th hour. Notably, pain during movement was significantly lower in Group I at both the 6th and 12th hours postoperatively (p=0.01 and p=0.04, respectively) (Table 2).

Regarding the timing of first opioid use after surgery, most patients in Group I required opioids after the 15th postoperative hour. In contrast, patients in Group II required opioids significantly earlier, indicating a statistically significant difference between the groups (p=0.03) Similarly, the total opioid dose administered within the first 24 hours after surgery was significantly lower (p=0.01). Postoperative vomiting and nausea were also less frequent in Group I (p=0.03 and p=0.04, respectively) (Table 3).

A statistically significant difference was found between the groups in terms of motor block resolution time. The duration of the motor block was 2.36±1.16 hours in Group I and 3.16±1.5 hours in Group II (p<0.002) (Table 3).

In Group I, patient satisfaction was 7.8±1.24, while in Group II, it was 7.27±1.46. The satisfaction level of patients who received the PENG block was statistically significantly higher (p<0.04) (Table 3).

DISCUSSION

In this comprehensive study, we compared pain before spinal positioning, patient satisfaction, time to first analgesic requirement, resolution of motor blockade, and complications such as nausea and vomiting in patients undergoing hip fracture surgery. The results showed that the PENG block was more effective than S-FICB in terms of EOSP, delayed opioid consumption, reduced pain during movement, quicker resolution of motor blockade, and higher patient satisfaction.

The use of regional analgesia is increasing due to its effectiveness in treating severe pain associated with hip fractures and its role in reducing opioid consumption.[12] Previous research has shown that regional anesthesia for hip fractures provides superior perioperative pain control compared to systemic opioids and lowers the risk of postoperative delirium.[13,14] S-FICB offers effective analgesia for hip fractures by comprehensively blocking the femoral nerve.[13] However, it does not consistently or sufficiently block the obturator nerve.[15] Despite this limitation, S-FICB provides potential benefits in hip fracture surgery, including improved pain management, reduced opioid use, enhanced patient positioning, and better cognitive outcomes.[2,16,17] Our study demonstrated that the fascia iliaca compartment block significantly reduced patients' pain during preoperative positioning and in the postoperative period.

Giron-Arango et al.[18] first described the PENG block as an effective method for providing perioperative analgesia in hip surgeries. The PENG block is an interfascial technique targeting the femoral, obturator, and accessory obturator nerves. Studies have demonstrated that the PENG block effectively alleviates discomfort during positioning for spinal anesthesia in hip fracture procedures.[2,19] Furthermore, it offers the advantage of preserving patient mobility without inducing motor blockade.[19] Pascarella et al.[20] found that the PENG block significantly reduced postoperative pain scores and opioid consumption in patients undergoing hip arthroplasty compared to a placebo. However, Zheng et al.[21] reported that the benefits of the PENG block, compared to intra-articular injection of a local anesthetic in total hip arthroplasty, are limited. Consistent with the existing literature, our study found that motor blockade resolved quickly and that pain during positioning and movement was significantly reduced, particularly within the first 12 hours postoperatively. Additionally, opioid consumption was minimal.

The PENG block has been observed to provide better pain relief for hip fractures compared to the fascia iliaca compartment block.[19,22–24] Mosaffa et al.[19] reported that the PENG block provided superior analgesia compared to the fascia iliaca compartment block during the first 12 hours postop-

eratively, prolonged the time to first analgesic requirement, and reduced postoperative opioid use. Natrajan et al.[22] found that the PENG block resulted in significantly better pain relief than the fascia iliaca compartment blocking at both 1 and 4 hours after hip fracture surgery performed under general anesthesia. Lin et al.[25] demonstrated that the PENG block offers enhanced and longer-lasting postoperative analgesia compared to the femoral nerve block, better preserves quadriceps strength postoperatively, and shortens discharge time following surgery. Previous research in the literature also indicates that the PENG block is more effective than the S-FICB for pain control during spinal positioning, while providing comparable postoperative analgesia.[13,24,26-28] Jadon et al.[23] compared the PENG block and S-FICB in hip fracture surgery and found that the PENG block provided better analgesia at the 12th postoperative hour, whereas the S-FICB offered greater analgesia at the 24th postoperative hour. Our investigation revealed that the PENG block significantly reduced pain during spinal anesthesia placement and during movement at six and twelve hours postoperatively. This intervention also led to a notable decrease in total opioid consumption within the first 24 hours after surgery, consistent with findings in the current literature.

In hip fracture surgeries, the PENG block has been shown to result in fewer motor blockades compared to the S-FICB and to better preserve muscle strength in the affected limb.[18,29] Choi et al.[27] demonstrated that muscle strength was similar between the two blocks. In our study, motor blockade resolved more quickly in patients who received the PENG block. Although previous studies have found no significant differences in the incidence of nausea and vomiting between these two techniques,[22,26,27] our study observed that nausea and vomiting occurred more frequently in patients who received the S-FICB block compared to the PENG block. We believe this is due to the need for earlier and more frequent opioid administration in this group. Studies analyzing the outcomes of PENG and S-FICB blocks have reported similarly high levels of patient satisfaction.[27,28] However, in contrast to these findings, our study observed higher patient satisfaction in the PENG group. We believe that this is due to the lower NRS scores, reduced nausea and vomiting, and better preservation of motor muscle strength during pre-spinal positioning in these patients.

Limitations

The limitations of our study include its retrospective design, the use of a single pain assessment tool, and the lack of classification regarding the types of fractures among the included patients. However, the study also has several strengths. Notably, a single anesthesiologist performed all preoperative nerve blocks, and one surgeon conducted all operations using the same brand of implants. Additionally, both preoperative and postoperative follow-up evaluations were carried out by an observer who was not involved in the anesthetic or surgical procedures, helping to minimize the risk of bias.

CONCLUSION

In summary, this study found that PENG blockade provided better analgesia during positioning, higher patient satisfaction, faster resolution of motor blockade, reduced opioid consumption, and a lower incidence of postoperative nausea and vomiting. These promising results suggest that the PENG block could significantly improve patient care in hip fracture surgery. However, further research involving different hip procedures and larger patient populations is needed to confirm these findings.

Ethics Committee Approval: This study was approved by the Bilecik Şeyh Edebali University Ethics Committee (Date: 10.03.2025, Decision No: KAEK-317238).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: M.G.; Design: M.G.; Supervision: M.G.; Resource: A.G.; Materials: A.G., M.G.; Data collection and/or processing: A.G., M.G.; Analysis and/or interpretation: A.G.; Literature review: A.G., M.G.; Writing: A.G., M.G.; Critical review: M.G.

Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Spinal anestezi altında intertrokanterik femur kırıkları nedeniyle ameliyat olan hastalarda perikapsüler sinir grubu bloğu ve suprainguinal fasya iliaka kompartman bloğunun etkilerinin karşılaştırılması; pozisyonlama, ilaç kullanımı, hasta memnuniyeti

AMAÇ: Çalışmamızın amacı, intertrokanterik femoral kırıkları nedeniyle ameliyat edilen hastalarda perikapsüler sinir grubu (PENG) bloğu ve supra-inguinal fasya iliaka kompartman (S-FICB) bloğunun perioperatif ağrı kontrolü üzerindeki etkilerini araştırmaktır.

GEREÇ VE YÖNTEM: Haziran 2021 ile Haziran 2024 arasında intertrokanterik femur kırığı nedeniyle ameliyat edilen hastalar retrospektif olarak analiz edildi. İntertrokanterik femur kırığı nedeniyle PENG bloğu veya S-FICB ile kombine edilen spinal anestezi altında proksimal femur çivisi kullanılarak ameliyat edilen hastalar çalışmaya dahil edildi. Çalışmaya katılan hastalar iki gruba ayrıldı ve değerlendirildi: PENG bloğu yapılan hastalar Grup I ve S-FICB yapılan hastalar Grup II içerisine dahil edildi. Hastaların fonksiyonel değerlendirmesinde, perioperatif sayısal ağrı skoru (NRS), kullanılan sistemik analjeziklerin miktarını ve zamanını, hasta memnuniyet skorunu, bulantı, kusmayı ve motor kas gücü skorları kullanıldı.

BULGULAR: Spinal pozisyonlama kolaylığı skoru Grup I'de önemli ölçüde daha iyiydi ($p<0.01$). Sayısal derecelendirme ölçeği (NRS), hareketle altıncı ve on ikinci saatte Grup I'de önemli ölçüde daha düşüktü ($p<0.001$). Hasta memnuniyet skoru Grup I'de önemli ölçüde daha yüksekti ($p=0.04$). Grup I'de ameliyat sonrası daha geç sürede opioid gereksinimi olurken kullanılan opioid miktarı Grup II'de daha yüksekti. (sırasıyla, $p=0.03$ ve $p=0.04$).

SONUÇ: Daha güçlü analjezik etkisi, daha kolay pozisyonlanma sağlanması, daha düşük opioid tüketimi ve daha iyi hasta memnuniyeti ile PENG bloğu, kalça kırığı cerrahisinde umut vadeden bir seçenek olarak ortaya çıkmaktadır. Çalışmamız, kalça kırığı cerrahisi planlayan hastalarda önce PENG bloğunun kullanılmasının daha faydalı olabileceğini düşündürmektedir.

Anahtar sözcükler: Perikapsüler sinir grubu, supra-inguinal fasya iliaka bloğu, spinal pozisyonlama kolaylığı, analjezi, spinal anestezi, kalça kırığı

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