ORIGINAL ARTICLE

Effectiveness of pericapsular nerve group block with ultrasonography in patients diagnosed with hip fracture in the emergency department

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ABSTRACT

BACKGROUND: Hip fractures (HF) are among the most common fractures present in the emergency department and are very painful. Pericapsular nerve group block (PENG) is a new regional anesthesia technique developed for analgesia in total hip arthroplasties. We aimed to determine the effectiveness of PENG block used to reduce pain in patients with HF in the emergency department.

METHODS: This single-center, randomized, and prospective study was carried out in the emergency department. The patients included in the study were selected according to the suitability of the personnel who will perform the procedure. The sealed envelope system was used for randomization.

RESULTS: Statistical analysis was performed with 39 patients (18 patients in the PENG group, 21 patients in the control group). Thirteen (33.3%) of the patients were female and 26 (66.7%) were male. The mean age was 75.3. At rest post-procedure, the mean Numeric Rating Scale (NRS) scores of the patients at the 30th min, 2nd, 6th, and 24th h were 1.78±1.83, 0.00±0.00, 0.00±0.00, and 1.28±1.41 in the PENG group. On the other hand, it was 3.38±1.86, 0.05±0.22, 2.86±2.37, and 4.95±1.47 in the control group, respectively. The mean NRS scores of the patients at 15° elevation of the leg at the 30th min, 2nd, 6th, and 24th h were 3.06±1.80, 0.06±0.24, 0.22±0.43, and 2.44±1.50 in the PENG group and it was 5.24±1.81, 1.05±0.92, 4.29±2.35, and 7.14±1.24 in the control group, respectively.

CONCLUSION: PENG block can reduce pain and the need for systemic analgesics as a practical option in patients with HF.

Keywords: Emergency physician; hip fracture; pericapsular nerve group block; ultrasonography.

INTRODUCTION

Hip fracture (HF) remains one of the most common injuries of the geriatric population.[1] Patients are usually admitted to the emergency department with severe hip pain due to falling.[2] Oral or intravenous (IV) analgesics are the first choice for pain management in HFs.[3] Geriatric cohort, comorbidities, limited physiological reserve, multiple drug uses, and side effects of systemic analgesics can pose challenges in pain management in the elderly.[4,5] Some systemic analgesic drugs may not provide adequate pain control.[3] In such cases, opioids are preferred because of their known significant analgesic effects. However, opioids have numerous side effects such as nausea, vomiting, sedation, delirium, and respiratory depression.[3] Conversely, regional anesthesia improves pain scores and mobility besides preventing opioid overuse, which has serious side effects.[3] Therefore, regional anesthesia, which has lesser complication rates, and side effects and more effective analgesic effects, is more widely used compared to analgesic drugs and opioid therapy.[6]

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Effective pain management in the patients with HF has been found to be associated with increased patient satisfaction, early recovery, and reduced hospital stay.[6] The most used regional anesthetic techniques are femoral nerve block (FNB), fascia iliaca compartment block (FICB), and three-in-one FNB.[7–9] However, these blocks may not provide adequate analgesia to the hip and may lead to quadriceps muscle weakness.[7–10]

Pericapsular nerve group block (PENG) is a new regional anesthesia technique developed in 2018 for analgesia in total hip arthroplasty with its motor protective benefits.[11] PENG block provides more effective analgesia and protects motor functions by blocking the articular branches of the femoral, obturator, and accessory obturator nerves in the hip with a single injection.[11] In many studies, PENG block was used successfully as a popular regional anesthesia technique for the management of acute pain in hip pathologies without causing quadriceps weakness.[7,10–13] PENG block, which was previously recommended only for HF analgesia, has been reported to be used in various indications such as hip dislocation, pelvic fractures, acetabular fractures, medial thigh surgery, and varicose surgery in recently published case reports and case series.[11–17] To the best of our knowledge, we have not found a randomized study involving the use of ultrasound-guided PENG block by emergency physicians. In this study, we aimed to determine the effectiveness of PENG block and hence reduced analgesic requirement for pain management in HF patients in the emergency department.

MATERIALS AND METHODS

This single-center, randomized, and prospective study was conducted in the emergency department of a training and research hospital with a capacity of 700 beds and 200,000 patient admissions annually. Annually, an average of 350 patients is diagnosed with HF in the emergency department of our hospital. The study was performed after approval from the Ethics Committee (Number: 44SBKAEK). Patients diagnosed with HF (femoral head or neck, intertrochanteric, and subtrochanteric) through X-ray or computed tomography in the emergency department were included in the study. In our ED, patients with a preliminary diagnosis of HF are diagnosed in an average 10 min with immediate commencement of analgesic treatment. During this study period, 51 patients were diagnosed with HF in the emergency department, but the study was conducted with 42 patients who finally consented. The patients included in the study were selected according to the suitability of the personnel performing the procedure. The inclusion criteria being: Conscious patients, aged over 18 and not on any previous opioids or addictive drugs. Patients presenting to ED with unstable vital signs, (systolic blood pressure <90 mmHg and heart rate <60 beats/min), infection at the injection site, kidney failure, bleeding disorder, neurological disease (Alzheimer's, dementia), psychiatric disease (schizophrenia), and those with history of local anesthetic allergy and weight <40 kg or >120 kg were excluded from the study.

Motor and nerve examinations of patients before PENG block were recorded. Sealed envelope system was used for randomization. Previously, equal number of envelopes was prepared for patients undergoing PENG block versus those receiving conventional analgesic therapy. After randomization, patients receiving PENG block were named as PENG group (Group P) while those who received medical treatment were coded under the control group (Group C). A sealed envelope was selected for each patient diagnosed with femoral fracture and meeting the inclusion criteria by a nurse who was unaware of the envelope contents. The patients were divided into two groups with these envelopes. Bupivacaine was used as a local anesthetic in the PENG block, while IV paracetamol and/or tramadol were given for systemic analgesics in the control group.

Before the procedure, patients were informed on the technique of analgesia provided to the randomization group. The difference between the groups regarding analgesic effect was evaluated using the Numeric Rating Scale (NRS) score. In the NRS score, 0 represents no pain, 1–3 represents mild pain, 4–6 represents moderate pain, 7–9 represents severe pain, and 10 represents very severe pain. All patients were informed about NRS and instructed to score their pain. In addition, all senior emergency department residents were informed about the NRS score. The physician performing the PENG procedure was blinded to the NRS scores of the patients both pre- and post-procedure. 1000 mg paracetamol (first choice) and 100 mg tramadol were used as IV medical treatment. All patients were asked about their NRS scores pre- and post-procedure (30th min, 1st, 2nd, 4th, 6th, 12th, and 24th h). If the NRS score of the patients was <4, systemic analgesia was not applied. The physicians responsible for the treatment of patients in the emergency department including the orthopedic team did not know which patient had received the block. Ultrasound-guided PENG block was performed by an emergency physician with a training background in ultrasonography and peripheral nerve block, having organized European-approved ultrasonography course. A standard dose of local anesthetic was administered to all patients in the PENG group with this technique. After the area was cleaned with an antiseptic solution, 2 ml of 1% lidocaine was applied to the skin.[11] Under aseptic conditions, the ultrasound (5–12 MHz high-frequency linear transducer, Philips Ultrasound System, Andover, USA) probe was placed transversely on the anterior inferior iliac spine (AIIS) and negotiated downward to visualize the pubic ramus. The femoral artery and iliopubic eminence were visualized. Accompanied by ultrasonography, 20 mL of 0.25% concentration of bupivacaine (5 mg/ml, Marcaine®) was injected between the psoas tendon and the posterior pubic ramus using a 21-gauge cannula (Stimuplex®-Canule 100 mm AB Braun, Melsungen AG, Germany). When successful dissemination of local anesthesia was observed on ultrasonogra-

phy, the entire volume of the same was injected. Main blood vessels and nerves were avoided and intermittent negative aspiration was performed to reduce the risk of intravascular injection or direct nerve damage (Fig. 1). Sensory dermatomal levels were checked to confirm the PENG block. The mean duration of PENG block, which included local antisepsis, ultrasonography, and local anesthetic injection, was 5 min. The patients were followed up for symptoms such as perioral tingling, metallic taste in the mouth, dizziness, blurred vision, tinnitus, drowsiness, seizures, and cardiovascular depression. In case of local anesthetic toxicity, lipid emulsion therapy was available.

The localization of HF, total analgesic and opioid consumption, complications, and NRS scores (at baseline, 30th min, 1st, 2nd, 4th, 6th, 12th, and 24th h) at rest and passive range of motion (15° passive limb elevation) were recorded for all patients. Non-invasive blood pressure readings, ECG rhythm, and O_2 saturation were monitored.

The patients whose records were obtained following the procedure were sent to the orthopedic service. In the orthopedics unit of our hospital, IV paracetamol and/or tramadol treatments are administered as routine systemic analgesics (IV paracetamol every 6 h and tramadol every 8 h). If the patient does not respond to these treatments, stronger opioid analgesics are used. Tramadol is the first preferred opioid in cases where paracetamol is ineffective. Analgesic consumption at the specified hours in orthopedic service was also recorded.

Statistical Methods

The statistical software SPSS (Statistical Package for the Social Sciences, Version 20, Chicago IL, USA) was used for calculations. All values presented as mean±standard deviation and mean (Maximum- Minimum) percent and frequencies. The results of the homogenity (Levene's Test) and normality tests (Shapiro Wilk) were used to decide which statistical methods to apply in the comparison of the study groups. Normally distributed and with homogeneous variances groups were compared two groups by Student's t-test and compared three or more groups by analysis of variance. Multiple comparison tests and the adjusted Bonferroni test were used. Repeated measures of analysis of variance were analyzed by Mauchy's sphericity test and Box's Test of Equality of Covariance Matrices. For comparisons of means of repeated measures, repeated measures analysis of variance was used. The corrected Bonferroni test was used for multiple comparisons. Categorical data were analyzed with Fischer's exact test and Chi-square test. P<0.05 was considered statistically significant. The sample size for the study was calculated using the "Repeated measurements analysis of variance" method, in which one of the factors was repeated in a factorial order. As a result of power analysis with 80% power, the sample size was determined as at least 36 people in total, with at least 18 people in each group.

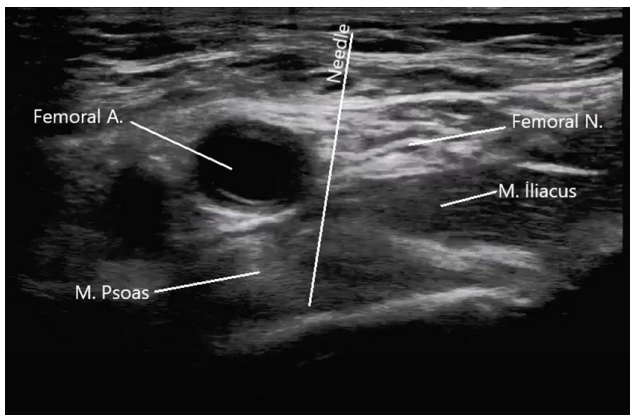

Figure 1. Sonoanatomy view for PENG block.

RESULTS

Forty-two patients were included in the study in October 2021. Three patients in the PENG group were excluded from the study as they were transferred to other center after the procedure. Thirteen (33.3%) patients were female and remaining 26 (66.7%) were males. The mean age was 75.3. The most common fracture types were femoral head fracture (51.3% in 20 patients) and intertrochanteric fractures (38.5% in 15 patients). The most common comorbidities were hypertension, cardiovascular diseases, and diabetes mellitus (Table 1). Statistical analysis was performed with 39 patients (18 patients in the PENG group and 21 patients in the control group) (Fig. 2).

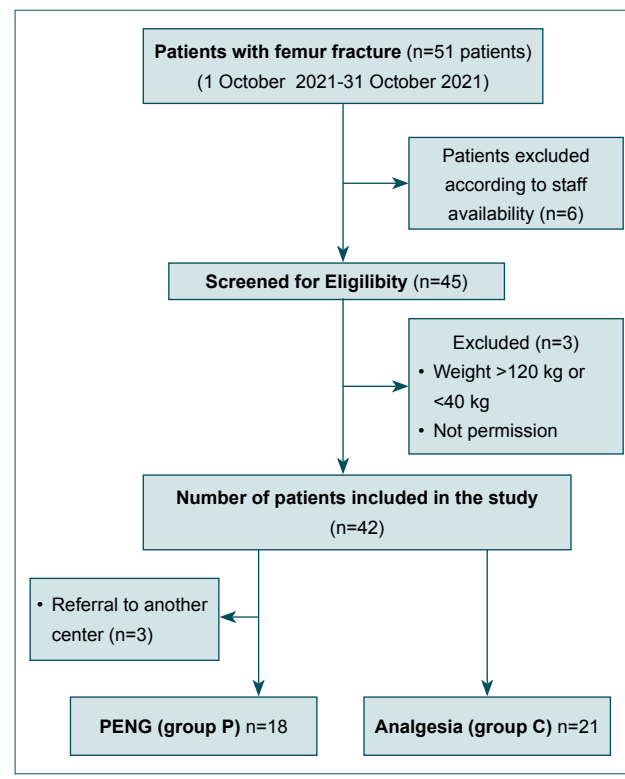

Figure 2. Study flow diagram.

Table 1. Demographical data of the patients

	Group P N, mean (%, min-max, ±SD)	Group C N, mean (%, min-max, ±SD)	Total N, mean (%, min-max)
Gender			
Female	6	7	13 (33.3)
Male	12	14	26 (66.7)
Age, years	78.6 (±10.51)	72.5 (±20.11)	75.3 (18–96)
Body Mass Index	24.67 (±4.97)	25.16 (±3.05)	24.93 (17.28–36.21)
Type of fracture			
Intertrchanteric fracture	8	7	15 (38.5)
Femoral head fracture	9	11	20 (51.3)
Subtrchanteric fracture	0	3	3 (7.6)
Femoral neck fracture	1	0	1 (2.6)
Comorbidity			
Coronary artery disease	9	16	25 (64.1)
Hypertension	9	16	25 (64.1)
Diabetes Mellitus	6	6	12 (30.7)
Cerebrovascular disease	2	3	5 (12.8)
Other	5	3	8 (20.5)

SD: Standard deviation.

Pre-procedure and the mean NRS scores of the patients at rest and at 15° elevation of the leg were 6.83±2.12 and 9.61±0.61 in the PENG group and 6.90±2.32 and 8.71±1.15 in the control group, respectively. At rest post-procedure, the mean NRS scores of the patients at the 30th min, 2nd, 6th, and 24th h were 1.78±1.83, 0.00±0.00, 0.00±0.00, and

Table 2. Distribution of patients' NRS scores over time in both groups

		Groups			
		Group PENG	Group Control	p	P
NRS Score with 15° straight leg-raise	Pre-processing	9.61±0.61	8.71±1.15	0.005	0.001
	30th minute	3.06±1.80	5.24±1.81	0.001	
	1st hour	0.56±0.92	2.19±1.29	0.001	
	2nd hour	0.06±0.24	1.05±0.92	0.001	
	4rd hour	0.22±0.43	3.33±2.52	0.001	
	6th hour	0.22±0.43	4.29±2.35	0.001	
	12th hour	1.28±1.41	6.33±1.49	0.001	
	24th hour	2.44±1.50	7.14±1.24	0.001	
NRS Score at rest	Pre-processing	6.83±2.12	6.90±2.32	0.921	0.001
	30th minute	1.78±1.83	3.38±1.86	0.010	
	1st hour	0.17±0.38	0.57±0.75	0.045	
	2nd hour	0.00±0.00	0.05±0.22	0.361	
	4rd hour	0.00±0.00	2.05±2.46	0.001	
	6th hour	0.00±0.00	2.86±2.37	0.001	
	12th hour	0.67±1.19	4.90±1.51	0.001	
	24th hour	1.28±1.41	4.95±1.47	0.001	

NRS: Numeric Rating Scale; PENG: Pericapsular nerve group block.

1.28±1.41 in the PENG group, respectively. Conversely, it was 3.38±1.86, 0.05±0.22, 2.86±2.37, and 4.95±1.47 in the control group, respectively. The mean NRS scores of the patients at 15° elevation of the leg at the 30th min, 2nd, 6th, and 24th h were 3.06±1.80, 0.06±0.24, 0.22±0.43, and 2.44±1.50 in the PENG group, while being 5.24±1.81, 1.05±0.92, 4.29±2.35, and 7.14±1.24 in the control group, respectively. When the NRS score was examined, a statistically significant difference was found between the two groups, favoring the PENG group, with an exception of the 2nd h NRS score at rest (p=0.001) (Table 2).

Paracetamol and tramadol IV treatment was planned, for the PENG group in cases where the NRS score was 4 or higher. In this group, two patients needed additional analgesics. Paracetamol was administered as an analgesic. Paracetamol was given to the first patient at 30 min and 12 h and to the second patient at 30 min and 24 h. None of the patients in the same group needed tramadol treatment.

DISCUSSION

This study demonstrated that PENG block analgesia provides as good and rapid pain control as conventional analgesia in HF patients. Significant decreases in NRS scores were observed in patients undergoing PENG block compared to patients receiving traditional analgesics at both rest and during passive movement. We also observed that the need for systemic analgesia (IV paracetamol and tramadol) was significantly lower in patients who underwent PENG block.

Unlike FICB and FNB, PENG block targets the joint branches, hence, eliminating the risk of weakness in the quadriceps muscles. In a small case series study by Girón-Arango et al.,[11] the efficacy of PENG block was demonstrated by, an average of 7 points reduction in pain scores. Similarly, in a study by Del Buono et al.,[18] it was found that there was a significant decrease in NRS scores in patients with femur fractures using PENG block. In a case series of ten patients analyzed by Acharya and Lamsal. It was observed that while the mean NRS scores ranged between 6 and 10 before PENG block, the same reduced to 3 or below following the procedure. They also stated that PENG block is an excellent analgesia option for position-related pain management in HFs.[10] Sahoo et al.[19] conducted a prospective and cohort study. In which they applied PENG block to 20 patients having undergone HF surgery with a visual analog scale (VAS) score greater than 5. Researchers recorded the values of VAS at rest and passive movement (15° straight leg-raise) following the block. They reported a significant decrease in VAS both at rest and during passive movement 30 min after the block. In another study, Sahoo et al.[20] applied PENG block to HF patients before the surgery. They compared the pre-block VAS scores with the 6th, 12th, and 24th h VAS scores. Hence, showing that PENG block was quite successful both at rest and during passive movement. Jadon et al.[21] stated that the landmark-based nerve stimulator-guided block technique could be used safely in patients with HF in cases where ultrasound is not available for PENG block. They also showed more than 50% reduction in pain at rest and during passive movement in all patients. Similar to above studies, our study showed that NRS scores were significantly reduced both at rest and in passive movement after PENG block.

There is no recommendation regarding the optimal dose of local anesthetic for use in PENG block. The volume of local anesthetic used for PENG block has been 20 mL of 0.25% bupivacaine.[10–12,18–21] In addition, higher volumes (30 ml) of local anesthetic were used in conditions such as pelvic fracture, acetabular fracture, medial thigh surgery and varicose surgery to achieve greater coverage area, and increased analgesic efficacy.[14–17,22] Girón-Arango et al.[23] stated that using more than 20 ml for FNB may cause undesirable motor blocks. In the cadaver study of Ciftci et al.,[24] 30 ml and 20 ml dye was used and they detected dye diffusion around the femoral nerve, femoral cutaneous nerve, and obturator nerve trace from inguinal to knee in the 30 ml group. Thus, they reported that this could explain the motor weakness in patients after high-volume anesthetic substance use. In the another study, Ahiskalioglu et al.[22] reported motor weakness in high volume PENG block application. Yu et al.[25] administered PENG block for analgesia to more than 100 HF patients with the same volume (20 ml). Quadriceps weakness developed in only two patients and resolved in 2 days. In accordance with the literature, we used 20 ml of bupivacaine for PENG block in our study and no complications developed in any patients.

A recent meta-analysis by Guay et al.[6] showed evidence supporting a significant reduction in pain within 30 min after nerve block. In addition, in case reports and case series related to PENG block, it was showed that adequate analgesia is provided within the first 30 min, and the need for systemic analgesics decreases in patients with HF.[12,15,19,20] In the case series conducted by Mistry et al.,[26] five patients with HF underwent PENG block. It was reported that all patients had pain relief within 10–15 min without quadriceps weakness. This contributes to increased patient and their kin's satisfaction, besides reduction in the consumption of systemic analgesics and the related side effects of these drugs. In their case report, Bilal et al.[15] successfully demonstrated that PENG block application could be used for post-operative analgesia in acetabular fracture surgery. They did not require opioid or rescue analgesic intake other than planned paracetamol. Sahoo et al.[20] applied PENG block preoperatively to HF patients. All patients were given 1 g IV paracetamol toward the end of the operation and 50 mg IV tramadol every 8 h in cases where VAS score was more than 5 points. Similarly, in our study, effective analgesia was provided within the first 30 min and the need for medical treatment, hence, decreased.

In addition, in two studies by Sahoo et al.,[19,20] patient satisfaction with PENG block was enquired. It was observed that

65% and 78% of the patients were satisfied. Similar to the literature, we found a patient satisfaction rate of 72%.

Limitations

Significant limitations of this study were that it was a single-center study, with a small sample size, and selection of a weakly acting opioid (tramadol). In addition, a study performed in the emergency department cannot represent the entire general population. Another limitation being that a single practitioner with high expertise performed the procedure. Furthermore, the same cannula and ultrasound were used throughout our study; when the type of cannula, ultrasonography equipment, and USG approach could potentially affect outcomes at other departments or institutions. Therefore, more research is needed comparing the PENG block alone or PENG with other blocks. In the light of these findings, multicenter, randomized, and controlled studies involving more patients with multiple practitioners need to be planned.

Conclusion

In both the emergency department and orthopedic ward, the mobility of HF patients is inevitable in situations such as personal needs, undressing for physical examination, additional imaging needs, and transfer to the operating table. All of these attribute to serious pain and adversely affect patient comfort. For this reasons, PENG block can reduce pain and the need for systemic analgesics as a practical option in patients with HF. In this patient population, it can be an ideal regional anesthesia technique for emergency physicians due to its effective analgesia, rapid performance, distance from risky areas, and motor function protective properties.

Ethics Committee Approval: This study was approved by the Aksaray University Faculty of Medicine Clinical Research Ethics Committee (Date: 07.10.2021, Decision No: 2021/12-02).

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Authorship Contributions: Concept: B.G., C.S., E.E.Ü.; Design: B.G., C.S., E.E.Ü.; Supervision: E.E.Ü., M.G.; Data: B.G., C.S., E.E.Ü.; Analysis: B.G., C.S., M.G., E.E.Ü.; Literature search: B.G., C.S., P.A., K.Ö., E.E.Ü.; Writing: B.G., C.S., P.A., K.Ö.; Critical revision: M.G., E.E.Ü., S.T.

Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Acil serviste kalça kırığı tanısı alan hastalarda ultrasonografi ile perikapsüler sinir grubu bloğunun etkinliği

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AMAÇ: Kalça kırıkları acil serviste en sık görülen kırıklar arasında yer alır ve çok ağrılıdır. Perikapsüler sinir grubu bloğu (PENG), total kalça artroplastilerinde analjezi için geliştirilmiş yeni bir bölgesel anestezi tekniğidir. Acil serviste kalça kırığı olan hastada ağrıyı azaltmak için kullanılan PENG bloğunun etkinliğini belirlemeyi amaçladık.
GEREÇ VE YÖNTEM: Bu tek merkezli randomize ileriye yönelik çalışma acil serviste gerçekleştirildi. Çalışmaya alınan hastalar, işlemi yapacak personelin uygunluğuna göre seçildi. Randomizasyon için kapalı zarf sistemi kullanıldı.
BULGULAR: Otuz dokuz hasta ile istatistiksel analiz yapıldı (PENG grubunda 18 hasta, kontrol grubunda 21 hasta). Hastaların 13'ü (%33.3) kadın, 26'sı (%66.7) erkekti. Ortalama yaş 75.3 idi. PENG grubunda işlem sonrası istirahatte 30. dakika, 2., 6. ve 24. saat hastaların ortalama NRS skorları 1.78±1.83, 0.00±0.00, 0.00±0.00 ve 1.28±1.41 idi. Kontrol grubunda ise sırasıyla 3.38±1.86, 0.05±0.22, 2.86±2.37 ve 4.95±1.47 idi. PENG grubunda bacağın 15° elevasyonunda 30. dakika, 2., 6. ve 24. saatte hastaların ortalama NRS skorları 3.06±1.80, 0.06±0.24, 0.22±0.43 ve 2.44±1.50 ve 5.24±. Kontrol grubunda ise sırasıyla 1.81, 1.05±0.92, 4.29±2.35 ve 7.14±1.24.
TARTIŞMA: PENG blok kalça kırığı olan hastalarda pratik bir seçenek olarak ağrıyı ve sistemik analjezik ihtiyacını azaltabilir.
Anahtar sözcükler: Acil uzmanı; kalça kırığı; PENG bloğu; ultrasonografi.

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