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Original Article

Comparison of the effects of two regional anesthetic techniques on pain during high risk hip fracture surgery

Sibel Seckin Pehlivan[1], Rıza Berat Ozdogan[2], Ozlem OZ Gergin[1], Burak Cakar[3], Adnan Bayram[1], Recep Aksu[1]

[1]Department of Anaesthesiology and Reanimation, Erciyes University, Medical Faculty, Kayseri, Turkey; [2]Department of Anaesthesiology and Reanimation, Kayseri State Hospital, Kayseri, Turkey; [3]Department of Orthopedic Surgery, Erciyes University, Medical Faculty, Kayseri, Turkey

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Abstract: Objectives: In this study, we evaluated perioperative pain management using the Analgesia Nociception Index (ANI) monitoring in high-risk ASA III-IV patients scheduled for hip surgery. Specifically, we examined the lumbar plexus (LP), sacral plexus (SP), and supra-inguinal fascia iliaca compartment blocks (SIFIB), as well as combinations of SP blocks. Methods: In this prospective observational study, we included 74 patients who were assigned to one of two groups: Group L, which received LP and SP blocks, and Group F, which received SIFIB and SP blocks. Surgery was performed after confirming the sensory block with the pinprick test and applying the sedation protocol. Sedation levels were evaluated using the BIS monitor whereas analgesic requirements were assessed using the ANI monitor. Demographic data, including age, sex, ASA score, SpO_2, heart rate (HR), mean arterial pressure (MAP), duration of sensorimotor block, type and duration of surgery, time to first analgesic use, and total analgesic consumption, were recorded. Visual analog scale (VAS) scores at 0, 6, 12, and 24 h additional analgesic requirements, and satisfaction ratings from patients and surgeons were also evaluated. Results: Compared to Group F, Group L presented significantly greater ANI values at 30, 60, 90 min intraoperatively, as well as at 6 and 12 h postoperatively. The VAS scores were consistently higher in Group F than in Group L at all measurement times. Conclusion: Group L provided better analgesia, required fewer sedatives during surgery, and had greater satisfaction among patients and surgeons. A negative correlation was found between the VAS score and ANI for assessing patient pain.

Keywords: Lumbar plexus block, sacral plexus block, supra-inguinal fascia iliaca compartment block, hip surgery, analgesia nociception index

Introduction

Hip fractures are a major public health concern, particularly among the elderly. More than 1.6 million cases are reported worldwide each year [1]. Patients with hip fractures often have multiple comorbidities, increasing their risk of postoperative morbidity and mortality. Both general anesthesia and neuraxial blocks are commonly used in hip surgery. However, in geriatric patients with comorbidities, general anesthesia can cause hemodynamic instability and may increase opioid requirements for postoperative pain management [2-4].

The use of neuraxial blocks can be challenging due to vertebral degeneration and anatomical complexities. Additionally, they are associated with an increased risk of complications, including sympathetic blockade, hypotension, and urinary retention [5, 6].

Peripheral nerve blocks (PNBs) offer a promising alternative for postoperative pain management, particularly in high-risk patients with fractures, as they carry a lower risk of complications. PNBs are used not only for analgesia but also as a primary anesthetic technique in select cases. Studies have demonstrated the successful use of lumbar plexus (LP), sacral plexus (SP), and supra-inguinal fascia iliaca compartment blocks (SIFIB), which target the sciatic, femoral, and obturator nerves in hip surgeries [7-9].

Accurately assessing perioperative analgesic needs is essential for preventing adverse outcomes. Pain, a subjective experience, poses

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challenges for objective measurement. Although unidimensional pain assessment tools such as the visual analog scale (VAS) and numeric rating scale (NRS) are widely used, researchers continue to explore more objective methods. In this context, the Analgesia Nociception Index (ANI) has gained attention as a non-invasive monitoring tool for evaluating parasympathetic system activity. The ANI assesses parasympathetic tone by analyzing subtle variations in heart rate (HR), which correlate with pain scores [10, 11].

In this study we objectively evaluated perioperative pain management using ANI monitoring in high-risk patients classified as American Society of Anesthesiologists (ASA) III-IV undergoing hip surgery. Specifically, we assessed pain management with LP and SP blocks, as well as with combinations of SIFIB and SP blocks. Additionally, we analyzed perioperative analgesic requirements and compared the efficacy of different block techniques.

Materials and methods

This prospective, observational study included 74 patients who underwent hip fracture surgery between November 2022 and October 2023. The study was approved by the local ethics committee (Approval number = 2022-707) and funded by the Erciyes University Scientific Research Projects Coordination under project number TTU-2022-12379. The study was registered with ClinicalTrials.gov (NCT05862922) and conducted in accordance with the guidelines of the Declaration of Helsinki.

Patients over 18 years of age who underwent hip surgery and were classified as ASA III-IV were included. Additional inclusion criteria required patients to have no contraindications for peripheral nerve block application, no arrhythmia, and no use of beta-blockers. Patients with allergies to the administered medications, psychiatric disorders, or opioid-dependence were excluded. Patients scheduled for bilateral hip fracture surgery, those with a history of prior hip fracture surgery, and those for whom the applied PSB was unsuccessful were also excluded. Before the study commenced, patients and their relatives were informed about its purpose. The anesthesia and analgesia methods were explained, and written informed consent was obtained at least 24 hours before surgery.

The cases were randomly divided into two groups using the closed envelope technique. Group L, which received LP and SP blocks, and Group F, which received SIFIB and SP blocks.

In the operating theater, patients underwent electrocardiography (ECG), non-invasive blood pressure measurement, and pulse oximetry monitoring, with perioperative pain assessment performed via monitoring of the ANI. A balanced crystalloid solution infusion of 5-10 mL/kg/h was initiated.

Patients in Group L, were placed in the lateral decubitus position with the surgical side facing upward. After sterilizing the surgical area, an experienced anesthesiologist used a low-frequency convex USG probe (Esota Mylab Sigma, Italy) to image the transverse process and psoas muscle at the L3-L4 level. A block needle (BRAUN Stimuplex Ultra 360 0.7 × 100 mm 22-G, Germany) was inserted in-plane with the USG transducer, and the LP was visualized within the psoas muscle. In case visualization was not achieved, the needle was advanced to the posterior third of the psoas muscle. To prevent intraneural injection and improve block success, initial stimulation of 1 mA was applied using a nerve stimulator (B. Braun Stimuplex® HNS, Germany) at a frequency of 1 Hz, targeting the quadriceps muscle area. When stimulation ceased at 0.3 mA, 0.25% bupivacaine (1 mg/kg) and 1% lidocaine (0.5 mg/kg) were injected. The SP block was then performed using the same convex USG probe while maintaining the patient in the same position. The transducer was placed at the midpoint of the line connecting the posterior superior iliac spine (SIPS) and the greater trochanter, to identify the iliac bone. The transducer was then moved inferomedially to visualize the sciatic notch. The hyperechoic SP was visualized between the sacrum and ischial bone, beneath the piriformis muscle. The block needle was advanced from the lateral end of the transducer via the in-plane method until it reached the SP, and dorsal/plantar flexion of the foot was observed following initial stimulation at 1 mA. When stimulation ceased at 0.3 mA, 0.25% bupivacaine (1 mg/kg) and 1% lidocaine (0.5 mg/kg) were administered. After 30 min, the sensory block was confirmed by conducting the pinprick test, and surgery commenced following the sedation protocol.

For patients in Group F, the suprainguinal fascia iliaca compartment block was performed using a high-frequency linear probe by the same anesthesiologist. After sterilizing the surgical area, the patient was placed in a supine position. The probe was placed longitudinally at the anterior superior iliac spine level, visualizing the iliacus muscle and fascia iliaca. A Slight tilt of the probe captured the characteristic "-bow tie-" image, identifying the deep circumflex iliac artery. The block needle was directed in-plane toward the iliac fascia, and 0.25% bupivacaine (1 mg/kg) and 1% lidocaine (0.5 mg/kg) were injected after confirming the correct site of injection. The SP block was then administered in the lateral position, using the same dose of local anesthetic. Surgery commenced after confirming the sensory block by conducting the pinprick test and applying the sedation protocol.

BIS (Aspect Medical Systems, USA) and ANI (MDolaris Medical Systems, France) were monitored. BIS levels were maintained between 80 and 90 (deep anesthesia: 0-40, general anesthesia: 40-60, deep sedation: 60-80, and superficial sedation: 80-100). ANI values were maintained above 50 (inadequate analgesia: 0-50, ideal analgesia: 50-70, high analgesia: 70-100). VAS scores were recorded pre-incision and postoperatively, and were classified as 0-4 (mild pain), 4-6 (moderate pain), 6-8 (severe pain), and 8-10 (very severe pain).

A propofol (1 mg/kg/h) and ketamine (0.5 mg/kg/h) infusion was initiated 10 minutes before the incision, and a fentanyl 50 mcg IV bolus was administered. During surgery, propofol and ketamine infusions were titrated based on ANI, BIS, behavioral indicators (grimacing, moaning, and restlessness), and hemodynamic changes (>15%) indicative of pain. The infusion of the sedative was stopped at the end of the surgery, and total anesthetic consumption was recorded.

Patients were monitored postoperatively in the post-anesthesia care unit (PACU) by a nursing team and an anesthesiologist who was uninvolved in the procedure. Postoperative analgesia management included paracetamol (1000 mg IV) for VAS scores ≥4, NSAIDs (dexketoprofen trometamol 50 mg IV) or tramadol (50 mg IV) if pain persisted, and ondansetron (3 mg IV) for nausea and vomiting. VAS scores were recorded at 0, 6, 12, and 24 h, along with additional analgesic requirements. Patient and surgeon satisfaction was assessed using a 4-point scale (1 = poor, 2 = good, 3 = very good, 4 = excellent).

The demographic and clinical data collected included age, sex, ASA score, SpO_2, HR, mean arterial pressure (MAP), duration of sensorimotor block, type and duration of surgery, time to first analgesic use, and total analgesic consumption. Patients were contacted over the telephone to assess their survival status 3 and 12 months after the operation.

Statistical analysis

All data were analyzed using IBM SPSS Statistics Standard Concurrent User V 29 (IBM Corp., Armonk, New York, USA). The normality of the variables was evaluated by conducting the Shapiro-Wilk test, while Levene's test was performed to assess group variance homogeneity. To determine differences in numerical variables between two groups, the independent samples t-test was conducted when the data followed a normal distribution; for data that did not follow a normal distribution, the Mann-Whitney U test was performed. Intragroup comparisons of VAS scores were made by conducting the Friedman test, with Bonferroni correction applied for multiple comparisons.

Categorical variables were compared between groups by conducting Yates' Chi-square test, Fisher-Freeman-Halton exact test, and Fisher's exact tests. When the results of the Chi-square test were significant, subgroup analyses were performed by conducting the Bonferroni-corrected two-ratio Z-test. The relationships between VAS and ANI values were assessed by conducting Spearman's correlation test. Comparisons of ANI values across VAS groups were made by conducting one-way ANOVA, with Duncan's test conducted for multiple comparisons. The predictive performance of ANI values for the VAS groups was evaluated by conducting a receiver operating characteristic (ROC) curve analysis. All results were considered to be statistically significant at $P<0.05$.

Results

In total, 74 patients who were 59-95 years old were included in the study. Two patients were

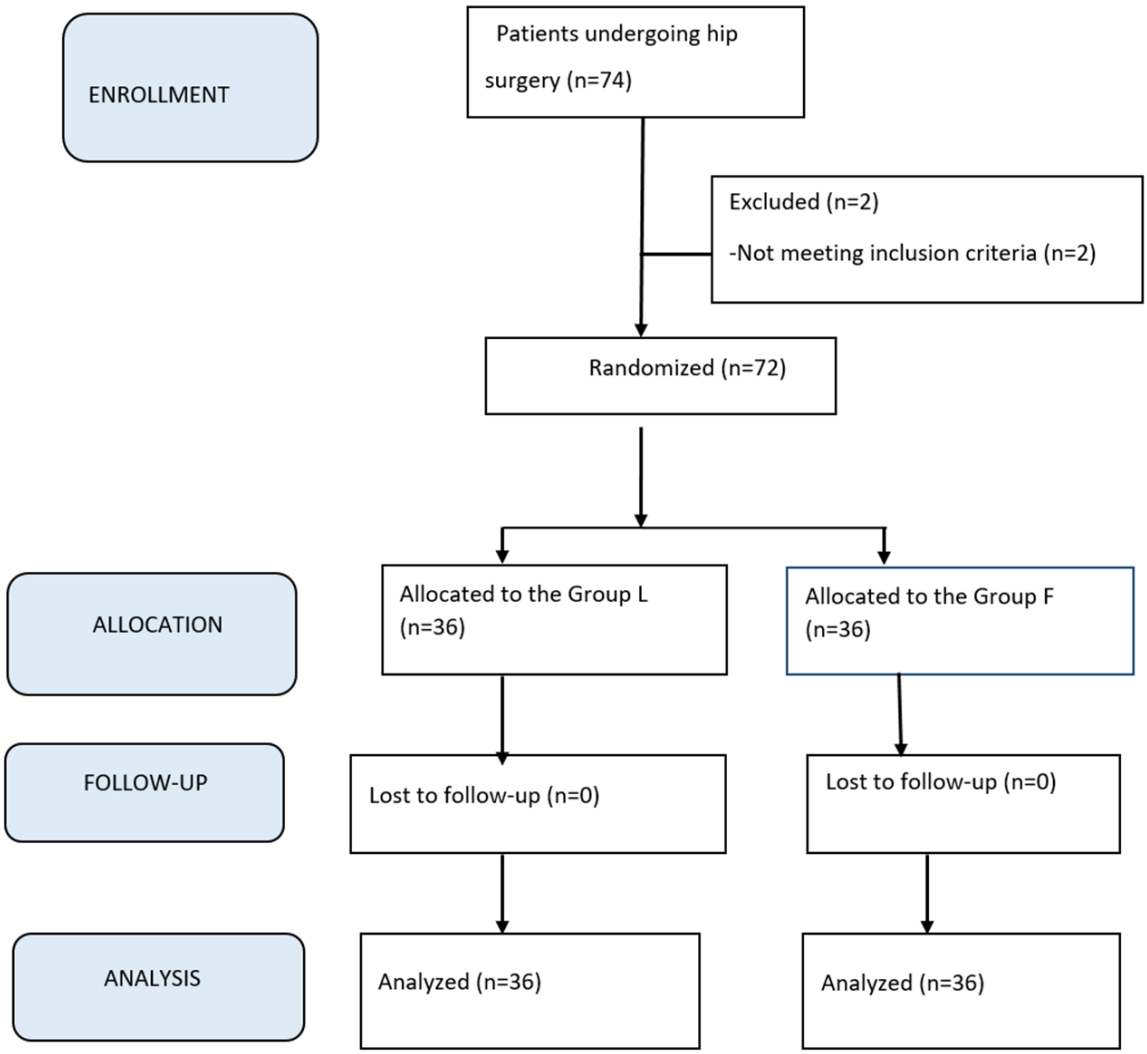

Figure 1. Flow chart of the patients.

excluded because of the need for vasopressors resulting from intraoperative bleeding (**Figure 1**).

A comparison of demographic characteristics, including age, weight, sex, ASA status, surgery duration, and type of surgery, revealed no significant differences between the groups (P>0.05) (**Table 1**). During surgical incision, the HR values were significantly greater Group F than in Group L (P=0.001), whereas the HR values at other measurement times were not significantly different between the groups (P>0.05) (**Figure 2A**). At postoperative minute 0, Group L had statistically higher MAP values than Group F, although these values remained within clinically normal limits (P=0.037) (**Figure 2B**). The BIS values (Group L, 81-90; Group F, 79-89) were not significantly different between the groups at any measurement time (P>0.05).

The ANI values for both groups generally fell within the 50-70 standard. However, Group L displayed significantly greater ANI values than Group F at 30, 60, and 90 min intraoperatively and at 6 and 12 h postoperatively (P<0.05). In Group F, the ANI value at 12 h postoperatively was significantly lower than that at baseline (pre-surgery) (P=0.009) (**Table 2**).

The VAS scores were consistently higher in Group F than in Group L at all measurement times (P<0.05). In Group L, the VAS scores were significantly greater at 12 and 24 h postoperatively than they were preoperatively (P<0.05) (**Table 3**).

Table 1. Demographic characteristics of patients

	Group L *n*=36	Group F *n*=36	Test Statistics	
			Test value	*p-value*
Age, (years)	80.9±7.6	80.2±8.2	0.416	0.678†
Weight, (*kg*)	69.08±10.08	73.58±9.18	1.979	0.052†
Sex				
Male	11 (30.6)	12 (33.3)	0.001	0.999Φ
Female	25 (69.4)	24 (66.7)		
ASA physical status				
III	32 (88.9)	35 (97.2)		0.357ǂ
IV	4 (11.1)	1 (2.8)		
Duration of operation, (min)	110.3±22.0	112.9±28.2	0.424	0.673†
Operation type				
Endoprosthesis	26 (72.2)	28 (77.8)	0.74	0.785Φ
PFN	10 (27.8)	8 (22.2)		

Data are given as mean±standard deviation values. †: Independent samples t-test, Φ: Yates Chi Square test, ǂ: Fisher exact test P<0.05 value was considered statistically significant. PFN: Proximal femoral nail, Group L: Lumbar Plexus and Sacral Plexus block group, Group F: Suprainguinal Fascia Iliac and Sacral Plexus block group.

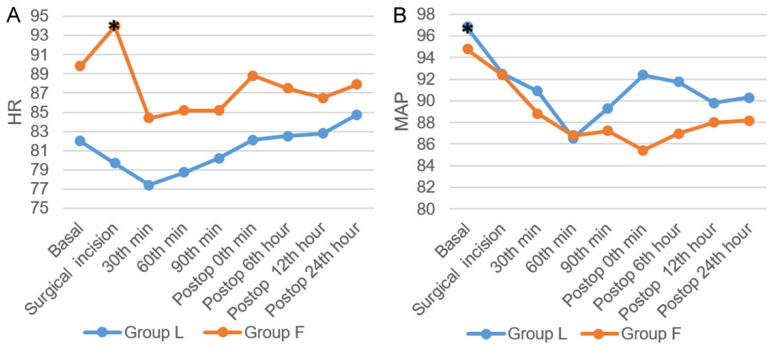

Figure 2. A. Comparison of Heart Rates (HR) by Groups at Measurement Times (The time point with statistically different data marked P<0.05); B. Comparison of Mean Arterial Pressures (MAP) by Groups at Measurement Times (The time point with statistically different data marked P<0.05).

One-way ANOVA of ANI values based on the VAS scores revealed differences at postoperative min 0 and h 12 (P=0.001 and P=0.007, respectively). ROC curve analysis was conducted to assess the ability of ANI values to predict severe and severe/very severe pain across VAS groups. At postoperative min 0, the ROC analysis between the VAS severe group and ANI values yielded an area under the curve (AUC) of 0.733, indicating statistical significance (P=0.001). The sensitivity and specificity for distinguishing severe pain (VAS score 6-8) at an ANI cutoff ≤66 were 80.0% and 61.5%, respectively (**Figure 3A**).

At the 12th postoperative hour, ROC analysis between the VAS severe/very severe group and ANI values yielded an AUC of 0.673 (P=0.007). The sensitivity and specificity for differentiating severe/very severe pain (VAS score 6-10) at an ANI cutoff ≤70 were 84.6% and 42.2%, respectively (**Figure 3B**).

Total propofol and ketamine consumption were higher in Group F (P<0.05). The sensory block duration was significantly longer in Group L than in Group F (P<0.001). More patients in Group F required their first analgesia dose at 6 h postoperatively (P=0.001), whereas for patients in Group L, this was more common at 12 h postoperatively (P=0.001). Compared to patients in Group L, those in Group F consumed more paracetamol (P=0.045), although NSAID and tramadol use did not differ significantly between the groups (P=0.632). Patient and surgeon satisfaction scores were significantly higher in Group L, with a greater number of participants rating satisfaction as excellent (P<0.001) (**Table 4**).

Both groups had similar distributions of additional comorbidities (P>0.05), and admission rates to the PACU or the ward were comparable (P=0.096). No significant difference was observed in hospital stay duration (P=0.227).

Table 2. The ANI values for perioperative and postoperative period

	Group L	Group F	Test Statistics	
			F-value	*p-value*
Basal	66.0±2.5	65.3±2.5	0.044	0.834
Surgical incision	67.7±2.7	61.6±2.7	2.513	0.117
Intraoperative 30th min	69.9±2.6	58.7±2.6	9.151	0.003
Intraoperative 60th min	72.7±2.7	64.6±2.7	4.359	0.040
Intraoperative 90th min	73.8±2.7	62.0±2.7	9.696	0.003
Postoperative 0th min	69.7±2.6	63.5±2.6	2.762	0.101
Postoperative 6th hour	68.9±2.4	59.0±2.4	8.194	0.006
Postoperative 12th hour	66.9±2.4	54.6±2.4$^{\psi}$	13.317	0.001
Postoperative 24th hour	69.2±3.0	62.1±3.0	2.829	0.097
Test Statistics: *F*; p*	1.118; 0.363	2.843; 0.009		

Data are given as mean±standard deviation values. P<0.05 value was considered statistically significant. *F:* It is the test statistic for comparisons between groups at each measurement time in mixed effects models. *F*:* In mixed effect models, test statistics for within-group comparisons in each group, ψ: It shows the values that are different from the baseline (pre-surgery). Group L: Lumbar Plexus and Sacral Plexus block group, Group F: Suprainguinal Fascia Iliac and Sacral Plexus block group.

Table 3. Comparison of VAS measurements

	Group L	Group F	Test Statistics	
			z-value	*p-value*
Basal	4.0 (1.0)	6.0 (1.0)	4.554	<0.001
Postoperative 0th min	4.0 (1.0)	5.0 (1.0)	3.911	<0.001
Postoperative 6th hour	4.0 (1.0)	6.0 (1.8)	4.866	<0.001
Postoperative 12th hour	5.0 (1.0)$^{\psi}$	6.0 (2.0)	2.547	0.011
Postoperative 24th hour	5.5 (1.0)$^{\psi}$	6.0 (2.0)	2.489	0.013
Test Statistics: χ^2; *p*	38.030; <0.001	9.376; 0.052		

Data are given as median (interquartile distance). P<0.05 value was considered statistically significant. z: Mann-Whitney U test statistics were used for comparisons between groups at each measurement time, χ^2: Friedman test statistics for intragroup comparisons within each group, ψ: It shows the values that are different from the baseline (pre-surgery). Group L: Lumbar Plexus and Sacral Plexus block group, Group F: Suprainguinal Fascia Iliac and Sacral Plexus block group.

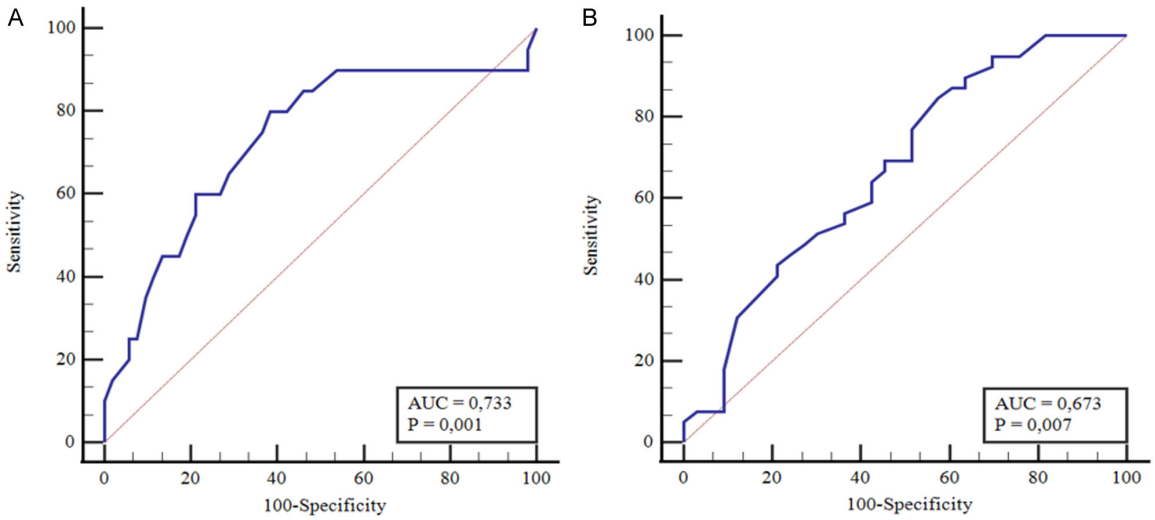

Figure 3. A. ROC Curve for the performance of ANI variable in predicting VAS (6-8) severe group at 0 minutes post-operatively; B. Curve for the performance of ANI variable in predicting VAS (6-10) severe/very severe group at 12th postoperative hour.

Table 4. Comparison of the groups drug consumption during sedation, duration of sensory block, time of first analgesic use, analgesic consumptions and satisfactions

	Group L		Group F		Test Statistics	
	n (36)	%	*n* (36)	%	*Test-value*	*p-value*
Propofol infusion (mg)	105 (50-300)		150 (75-250)		3.098	0.002[&]
Ketamin infusion (mg)	57.5 (25-100)		75.0 (40-150)		2.833	0.005[&]
Duration of Sensory Block (hour)	5.0 (3.0-10.0)		4.0 (3.0-7.0)		4.579	<0.001[&]
Time of First Analgesic Use					12.300	0.001[¥]
Postoperative 6th hour	20	55.6[a]	33	91.7[b]		
Postoperative 12th hour	15	41.7[a]	3	8.3[b]		
Postoperative 24th hour	1	2.8[a]	0	0.0[a]		
Paracetamol (g)	2 (1-3)		3 (1-4)		2.006	0.045[&]
NSAID (mg)	100 (50-100)		150 (50-150)		1.74	0.082[&]
Opioid (mg)	50 (50-150)		50 (40-150)		-0.552	0.632[&]
Patient Satisfaction					28.435	<0.001[¥]
Poor	0	0.0[a]	7	19.4[b]		
Good	4	11.1[a]	17	47.2[b]		
Very good	16	44.4[a]	10	27.8[a]		
Excellent	16	44.4[a]	2	5.6[b]		
Surgeon Satisfaction					20.673	0.001[¥]
Poor	0	0.0[a]	6	16.7[b]		
Good	3	8.3[a]	12	33.3[b]		
Very good	15	41.7[a]	14	38.9[a]		
Excellent	18	50.0[a]	4	11.1[b]		

Numerical variables are given as median (min-max). P<0.05 value was considered statistically significant. &: Mann-Whitney U test, ¥: Fisher-Freeman-Halton exact test; superscripts a and b in the same row indicate differences between groups. There is no statistical difference between the groups containing the same superscripts. Group L: Lumbar Plexus and Sacral Plexus block group, Group F: Suprainguinal Fascia Iliac and Sacral Plexus block group; n: Number of patients, %: Column percentage.

Survival rates did not differ significantly between the groups (P=0.766), with no mortality in either group at three months. The one-year mortality rates were 16.7% for Group L and 22.2% for Group F.

Discussion

This prospective observational study evaluated perioperative pain management using ANI monitoring in patients undergoing hip surgery, and compared LP and SP block combinations to SIFIB and SP block combinations. The findings indicated that the LP-SP block group provided more effective analgesia, required lower intraoperative sedative doses, and resulted in higher patient and surgeon satisfaction.

Peripheral nerve blocks (PNBs) are considered the gold standard for postoperative multimodal analgesia in lower extremity surgeries, as they can reduce opioid consumption. PNBs have gained popularity due to their unilateral nature, lower neurotoxic risk, and minimal impact on the cardiovascular system [3].

De Leeuw et al. reported effective anesthesia for hip replacement surgery using LP and L1 paravertebral blocks [12]. Similarly, Petchara et al. studied high-risk hip fracture patients and found that LP and SP blocks provided effective anesthesia in 70 patients, with no motor block developing on the non-surgical side, allowing surgeries to proceed without general anesthesia [13]. In our study, no motor block was observed on the non-operated side in Group L, confirming that the local anesthetic did not spread to the contralateral lumbar plexus, epidural space, or subarachnoid space. Although rare, this complication can lead to bilateral motor and sensory block. However, general anesthesia was not required for any patient in our study.

Zhao et al. suggested that using SIFIB and SP blocks in hip fracture surgery may improve

mortality outcomes in frail patients [14]. In a retrospective study, Genç et al. reported mild-to- moderate mid-thigh pain in patients receiving SIFIB and SP blocks for lower extremity surgeries, with propofol (1 mg/kg/h) and ketamine (10 mg) administered as needed [15]. Vermeylen et al. noted that inadequate local anesthetic volumes in SIFIB blocks can result in insufficient sensory blockade, particularly affecting the obturator, ilioinguinal, genitofemoral, and subcostal nerves [9]. In our study, no block failures were observed, and all patients successfully underwent surgery under sedation alone.

Pain assessment and management require close collaboration with patients due to the subjective nature of pain. While VAS and NRS scores remain the gold standards for pain assessment, ANI offers a non-invasive, objective alternative [10]. ANI monitoring evaluates parasympathetic tone, with higher ANI values indicating lower pain intensity and lower ANI values suggesting a higher pain intensity [11]. ANI is widely used for pain assessment, particularly under general anesthesia and in the postoperative period, with values between 50- and 70 associated with opioid consumption [16]. In our study, both groups maintained ANI values within this range on average, suggesting good surgical tolerance with sedation following block administration.

Sabourdin et al. highlighted the challenges in interpreting ANI values under general anesthesia and sedation, while Jess et al. reported that although ANI values decreased after both painless and painful stimuli, no correlation with the NRS score was observed, underscoring the limitations of ANI in assessing pain intensity [17, 18]. Conversely, Boselli et al. found a negative correlation between ANI and VAS in the early postoperative period, demonstrating that as pain intensity increased, ANI values decreased [11]. Similarly, our study also revealed a weak negative correlation between VAS scores and ANI at baseline, 0 min, and 6 h. Additionally, Group L exhibited higher ANI values than Group F at 30, 60, and 90 min intraoperatively and at 6 and 12 h postoperatively, suggesting that Group L provided superior intraoperative and postoperative analgesia.

Boselli et al. conducted a ROC analysis and found that an ANI threshold of <50 predicted postoperative pain with 86% sensitivity and a 92% negative predictive value for distinguishing patients with NRS≤3 from those with NRS>3 [11]. In our study, ROC analysis between VAS severe and ANI values at postoperative minute 0 yielded an AUC of 0.733 (P=0.001), with 80% sensitivity and 61.5% specificity for an ANI cutoff ≤66, suggesting that a VAS severe threshold (6-8) may correspond to ANI≤66. Similarly, at the 12th postoperative hour, ROC analysis yielded an AUC of 0.673 (P=0.007), with 84.6% sensitivity and 42.2% specificity for an ANI cutoff ≤70, indicating that a VAS severe/very severe threshold (6-10) may correspond to ANI≤70. These findings exceed previously reported ANI reference values, which may be attributed to differences in patient populations and surgical procedures, particularly given that the mean age in our study was 80 years.

Although surgical techniques and perioperative care have advanced considerably, postoperative pain management remains challenging. Multimodal analgesia and PNBs are recommended as the gold standard for lower extremity surgeries due to ther benefits, including reduced opioid use, lower neurotoxic effects, and minimal cardiovascular. Consequently, PNBs have gained widespread popularity [3, 19].

Studies comparing SIFIB and LP blocks have shown that SIFIB is as effective as LP blocks in terms of VAS scores and analgesic needs [20]. One study reported that SIFIB reduced opioid consumption by 48% within the first 24 hours [21]. In total hip replacement surgery, SIFIB provided a longer sensory block duration than LP, although both techniques were equally effective in pain control. Bravo et al. found no significant differences between the SIFIB and LP block groups regarding paracetamol, NSAID, and opioid use [22]. Bielka et al. reported that patients receiving LP and SP blocks for hip fractures did not require analgesia within the first 24 hours postoperatively [23]. In our study, patients in Group F required significantly more paracetamol as additional analgesia than those in Group L, although NSAID and tramadol consumption did not differ significantly between groups. Additionally, patients in Group L had a longer block duration than those in Group F, leading to earlier analgesia requirements in Group F patients.

In geriatric patients, hip fractures increase the risk of postoperative morbidity and mortality, influenced by factors such as age and preexisting cardiovascular and respiratory conditions [24]. Studies comparing anesthesia methods have shown that combined sciatic and paravertebral nerve blocks result in lower intraoperative hypotension and reduced ICU admission rates compared to general anesthesia [25]. Additionally, paravertebral nerve blocks have been associated with lower 30-day and three-month mortality rates than spinal anesthesia, although one-year mortality rates do not differ significantly [26]. In our study, no mortality was receorded within the first three months postoperatively. The one-year mortality rates were 16.7% in Group L and 22.2% in Group F, with no significant difference between the groups.

Aissa et al. investigated the use of LP and SP blocks as an anesthetic technique in 30 hip fracture patients and reported that this combination is a viable alternative to neuraxial and general anesthesia. Among these patients, 73% rated their surgeon satisfaction as 10/10, whereas 26% rated it as 9/10. Additionally, 86.6% of patients were satisfied with the anesthetic technique used and stated that they would choose the same method for future procedures [27]. In our study, surgeon satisfaction scores in Group L were 4/4 in 50% of cases and 3/4 in 41.7% of cases, Furthermore, 88.8% of patients in Group L rated their experience as "-very good-" or "-excellent-".

This study had some limitations. Its single-center design was a notable constraint. Additionally, the use of intraoperative sedation prevented direct comparisons of intraoperative VAS and ANI values. The high proportion of ASA III and IV patients with significant comorbidities likely affected standardization.

PNBs represent a promising alternative to general and neuraxial anesthesia for high-risk patients undergoing hip surgery. Objective pain monitoring is essential for effective analgesic management. We recommend future multicenter studies with homogeneous patient populations receiving PNBs to further evalute VAS and ANI assessments. While ANI shows potential as a pain-monitoring tool, further research is needed to assess its applicability across different surgical and pain management settings.

In this prospective observational study, LP and SP block, as well as SIFIB and SP block combinations, were effective for perioperative anesthesia and pain management in patients undergoing hip surgery when combined with sedation. However, the LP and SP block groups provided superior analgesia, required fewer intraoperative sedatives, and achieved higher patient and surgeon satisfaction. A negative correlation was observed between VAS and ANI scores in pain assessment. ROC analyses results suggest that postoperative ANI values in sedated patients may serve as a reliable threshold for identifying severe and very severe pain, aiding in pain management. However, further studies involving diverse surgical procedures and patient populations are needed to validate these findings.

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Disclosure of conflict of interest

None.

Address correspondence to: Sibel Seckin Pehlivan, Erciyes University, Medical Faculty, Talas, Kayseri, Turkey. Tel: +90-352-2076666-24048; Fax: +90-352-4377333; E-mail: sibelpehlivan@erciyes.edu.tr

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