ORIGINAL ARTICLE

A Comparative Study between Ultrasound guided Pericapsular Nerve Group Block and Suprainguinal Fascia Iliaca Compartment Block for Analgesia following Hip Surgery

Moustafa I. M. Shalaby, Ahmed M. A. Elnaggar, Mohamed S. I. Mohamed *

Department of Anesthesia, Intensive Care and Pain Management, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***Patients with fractured hips almost always have marked pain that results in increased opioid consumption and unfavorable opioid-induced side effects and motor weakness, especially in elderly patients. To mitigate pain associated with hip procedures, the pericapsular nerve group block (PENG) has been developed as an innovative method designed to enhance analgesia while preserving motor function.***

Aim and objectives: ***To examine the postoperative analgesic effectiveness following hip surgeries utilizing two distinct techniques: Pericapsular Nerve Group Block (PENG) and Suprainguinal Fascia Iliaca Compartment Block (FICB).***

Subjects and methods: ***This randomized double-blind experiment involved 70 participants aged 40 to 65 years, classified as ASA I-II, with hip fractures planned for surgery under general anesthesia. Cases were randomly assigned equally to two groups.***

Results: ***The duration until the initial rescue analgesia was extended in the PENG group (492.84±99.06 minutes) compared to the S-FICB group (438.58±57.45 minutes), and the total opioid requirement was reduced in the PENG group relative to S-FICB ($p<0.001$). After 20 minutes, the heart rate was considerably lower in the PENG group compared to the FICB group. VAS exhibited a substantial reduction in the PENG group compared to the SFICB group during both rest and movement.***

Conclusion: ***PENG provided superior benefits by extending the duration to initial rescue analgesia, reducing narcotic usage within the first 24 hours post-hip operations, and enhancing quadriceps strength recovery compared to S-FICB.***

Keywords: PENG; FICB; Analgesia; Hip Surgery

1. Introduction

Hip surgeries are regarded as among the most prevalent procedures in orthopedic surgery. Postoperative analgesia and prompt recovery significantly influence the functional prognosis after hip operations.

Effective pain treatment post-hip surgery is crucial for prompt ambulation and patient satisfaction. Nonetheless, due to the intricate innervation of the hip joint, the ideal localized analgesia approach remains contentious.[1]

Typically, hip operations are performed under subarachnoid blocks, complicating postoperative pain management. The fascia iliaca compartment block (FICB) is a widely utilized localized analgesic method among anesthesiologists for delivering both immediate and postoperative analgesia in cases of hip fractures.

The pericapsular nerve group (PENG) block has recently been suggested as an effective analgesic intervention for individuals with hip fractures.[2]

A supra-inguinal fascia iliaca block (FICB) facilitates superior distribution beneath the fascia iliaca by administering local anesthetic in a more cranial position, perhaps decreasing pain scores. Although these blocks were inadequate for achieving full analgesia due to the preservation of articular accessory nerves.[3]

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* Corresponding author at: Anesthesia, Intensive Care and Pain Management, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: Bamboogiee_8@yahoo.com (M. S. I. Mohamed).

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Numerous case reports have demonstrated the efficacy of the PENG block in alleviating postoperative pain after hip surgery, while also decreasing opioid usage and mitigating opioid-related side effects, which is crucial for this elderly patient.[4]

This study aimed to examine the postoperative analgesic efficacy following hip surgeries utilizing two distinct approaches: PENG and FICB.

2. Patients and methods

From October 2023 to October 2024, seventy patients were included in this prospective, randomized, controlled, double-blinded clinical trial at Cairo's Al-Azhar University facilities. subsequent to the recommendation of our Institutional Review Board.

Ethical Consideration:

After receiving approval from the Institutional Ethical Committee, the study was conducted. All pregnant women who were interested in taking part in the study or seeing the block technique demonstrated their permission in writing.

Inclusion criteria:

Included in this study were all patients (40–65 years old) who were scheduled to have surgery for a hip fracture while under general anesthesia.

Exclusion criteria:

Disinterested or unwilling patients, those with ASA III–IV, a history of inherited or acquired coagulopathies or concerns about intraoperatively discovered coagulation defects, known allergies to local anesthesia or any study medications, infection at the injection site, platelet count below 80,000, body mass index (BMI) greater than 35, and motor and sensory neurological diseases affecting the lower extremities that could impact pain assessment or postoperative motor function are all disqualifying factors.

Sample size calculation:

Utilizing G.power (Universitay Kiel, Germany), the sample size computation was executed. Based on the following factors, the sample size was determined to be n≥31 in each group: To prove that there is a difference, the study must have a power of 90% and an error rate of 0.05. Comparison of the primary result, the time to first rescue analgesia, between patients who undergo PENG and those who undergo FICB within the first 24 hours following surgery. To account for attrition, four additional cases were added to each group, bringing the total number of patients to 35 in each.

Randomization and blindness:

The allocation of patients was done randomly using computer-generated randomization numbers, and the codes for each patient were stored in a sealed, opaque envelope. The patients were divided into two equal groups using a 1:1 allocation ratio and randomly assigned: In Group A, patients received a PENG solution containing 20 mL of bupivacaine 0.25% with epinephrine, while in Group B, patients received an FICB solution containing 30 mL of bisphosphonate with epinephrine.

Laboratory investigations (full blood count, coagulation profile, liver function test, renal function test) were administered to all patients after thorough medical and surgical history collection and general and airway clinical examinations. Everyone over the age of 40 or with a history of chest pain had an electrocardiogram (ECG) and a chest x-ray.

Materials:

A mixture of 5% povidone-iodine and 70% ethyl alcohol, Bupivacaine hydrochloride 100 mg/20 ml, often known as Sunny pivacaine, contains 0.5% isobaric bupivacaine. The 22Gx90 mm Univer spinal needle was manufactured in Saitama, Japan. A 3-5MHz curved-type probe with an ultrasound machine (M-Turbo, SonoSite Inc., USA).

PENG group:

Above the inguinal ligament, the SonoSite inc., USA-based company's curvilinear low-frequency ultrasonic probe (2-5MHz; C60xp; M-Turbo) was positioned. After that, it was rotated 45 degrees to reveal the psoas tendon, iliopubic eminence, and anterior inferior iliac spine.

Hydrodissection was used to implant a 22-gauge, 80mm needle into the target area, with the tip placed in the musculofascial plane between the pubic ramus posteriorly and the psoas tendon anteriorly. The needle was entered using an in-plane approach. A total amount of 20 mL of a mixture of 0.25% bupivacaine and 1:200,000 epinephrine was injected after negative aspiration.

FICB group:

Below the anterior superior iliac spine, in the sagittal plane, the linear 6-13MHz ultrasonic probe (M-Turbo, SonoSite Inc., USA) was positioned over the inguinal ligament. By sliding the probe medially and rotating it until the "bow-tie sign" formed by the sartorius and internal oblique muscle was identified, a 22-gauge, 80mm needle was inserted 1cm cephalad to the inguinal ligament. The needle tip was then placed in the space between the internal oblique and iliacus muscles using the hydrodissection technique. After the aspiration was negative, 30 milliliters of a mixture of 0.25% bupivacaine and 1:200,000 epinephrine was administered.

In the 30 minutes following the block, patients were watched for symptoms of local anesthetic toxicity using non-invasive blood pressure monitoring every 5 minutes, continuous electrocardiogram (ECG), and pulse oximetry.

Postoperative management:

At times 0, 2, 4, 8, 12, 16, and 24 hours after

surgery, patients were asked to take the Visual Analogue Scale (VAS) to measure their pain. However, only the VAS scores taken at regularly scheduled times were used for statistical analysis. The pain assessment and management protocol was reviewed by a member of the on-duty Orthopedic ward staff who was not informed of the patients' group allocation. At the patient's request, when the VAS score was four or higher and the time was recorded, all patients in the groups were given an infusion of 30 mg of ketorolac and 10 mg of paracetamol per kilogram over a 10-minute period.

If the patient's VAS score remained at four after 30 minutes of administering the ketorolac-paracetamol, rescue analgesia was administered with an intravenous bolus of 4 mg of nalbuphine, and the procedure could be repeated 30 minutes later if necessary.

This patient was considered a failure rate for that procedure when reevaluated 30 minutes after the second nalbuphine dose; however, he proceeded with the experiment and his data were assessed if VAS remained ≥4 despite the use of NSAIDS (paracetamol) and two consecutive doses of nalbuphine.

The maximum dosage that could be administered within the first 24 hours was four doses of ketorolac-paracetamol. In cases when the patient requires additional analgesic effects, top-up dosages of nalbuphine up to 0.45 mg/kg, or approximately 30 mg/day, were permitted, but not beyond, in pregnant women with an average weight of 70 kg.

Statistical Analysis:

IBM SPSS v28 (Chicago, IL, USA) was used to analyze the data. The qualitative variables were examined using a Chi-square test, which recorded percentages and frequencies. Quantitative variables were compared using Student's t-test or Mann-Whitney test for non-normal distributions, and means±standard deviation (SD) for normal distributions. Statistical significance was defined as a two-tailed P-value below 0.05.

3. Results

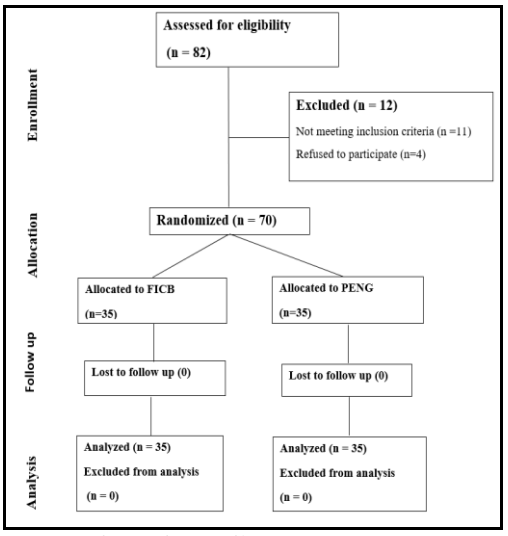

Figure 1. Flow chart diagram.

Table 1. Using demographic data, compare the groups that were researched.

		GROUP-A (PENG) (N=35)	GROUP-B (FICB) (N=35)	T	P-VALUE
Age					
Mean±SD		61.5±2.5	59.7±3.5	0.459	0.955
Gender	Male	17 (48.5%)	15(42.8)	x2	
	Female	18(51.5)	20(57.2)	0.23	0.631
BMI(kg/m^2)					
Mean±SD		25.6±2.3	25.5±2.5	0.1742	0.862
ASA	I	16(45%)	12(35%)	x2	
	II	19(55%)	23(65%)	0.952	0.329
Duration of surgery(min)					
Mean±SD		90±10	78±15	5.315	0.822
Blood loss(ml)					
Mean±SD		330±90	400±80	1.316	0.936
Type of surgery					
Total hip arthroplasty		18(51.4)	19(54.3)	x2 0.681	0.995
Cannulated screw fixation		10(28.6)	8(22.9)	x2 1.882	0.628
Proximal Femur Nail(PFN)		7(20)	8(22.9)	x2 0.921	0.915

Using:T (unpaired student t test, X2:Chi-square. p-value>0.05 NS.

The age distributions of the two groups were similar; group-A had a mean of 61.5±2.5 years and group-B 59.7±3.5 years. Statistical analysis revealed no statistically significant distinction between the two groups (p=0.955).

Group A consisted of 17 males and 18 females, or 48.5% and 51.5% of the total, whereas group B included 20 males and 15 females, or 42.8% and 57.2% of the total, respectively; nevertheless, there was no statistically significant distinction between the two groups (p=0.631).

Both groups had similar body mass index (BMI), with group-A at 25.6±2.3kg/m2 and group-B at 25.5±2.5kg/m2. There was no statistically significant distinction between the two groups (p=0.862).

There was no statistically significant distinction between the two groups with a p-value of 0.329, therefore 16(45%) patients in group A and 12(35%) patients in group B had ASA I, and 19(55%) patients in group A and 23(65%) patients in group B had ASA II.

The two groups were comparable with no statistically significant difference in duration of surgery as regards group-A and B was 90±10 min and 78±15 min, with p-value(p=0.822).

Regarding blood loss, it was in each group-A and B was 330±90ml and 400±80 ml respectively, with p-value(p=0.936).

Also regarding that, Type of surgery was total hip arthroplasty in group-A and B which was 18(51.4%) patients and 19(54.3%) patients respectively, with p-value(p=0.995), cannulated screw fixation in group-A and B was 10(28.6%) patients and 8(22.9%) patients with p-value(p=0.628) and proximal femur nail in group-A and B was 7(20%) patients and 8(22.9%) patients with p-value(p=0.915).

In all types of surgery in this study there were no statistically significant difference between both groups,(table 1; figures 2&3).

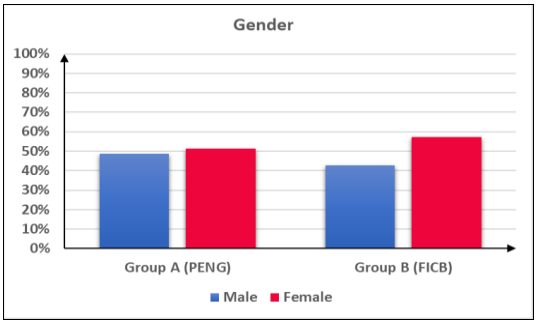

Figure 2. Gender distribution in the two study groups.

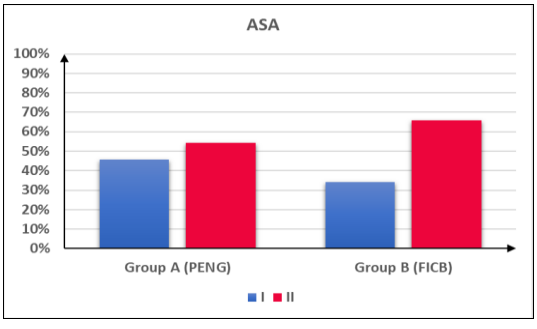

Figure 3. ASA physical status in the two study groups.

Table 2. Analysis of the research groups based on their static VAS scores.

VAS SCORE	GROUP-A (PENG) (N=35)	GROUP-B (FICB) (N=35)	T-TEST VALUE	P-VALUE
T BASE				
MEAN±SD	5.57±1.58	4.98±2.15	1.33	0.189
MEDIAN(IQR)	7(6–8)	7(5–8)		
RANGE	4–10	5–10		
T0 (AT PACU)				
MEAN±SD	4.25±1.88	4.75±1.38	29.151	0.822
MEDIAN(IQR)	4(3–5)	5(3–6)		
RANGE	3–8	3–7		
T2				
MEAN±SD	2.41±0.76	3.26±0.73	27.613	0.550
MEDIAN(IQR)	3(2–3)	3(3–4)		
RANGE	1–5	2–6		
T4				
MEAN±SD	3.06±0.84	2.26±0.86	19.896	0.086
MEDIAN (IQR)	3(3–4)	2(2–3)		
RANGE	1–5	1–4		
T8				
MEAN±SD	2.41±1.34	3.06±1.21	8.981	0.011*
MEDIAN(IQR)	3(3–4)	3(2–3)		
RANGE	1–5	1–6		
T12				
MEAN±SD	3.11±1.08	3.90±1.22	34.519	0.027*
MEDIAN(IQR)	3(2–3)	4(3–4)		
RANGE	1–6	2–7		
T16				
MEAN±SD	2.72±0.99	3.13±0.88	6.178	0.458
MEDIAN (IQR)	2(2–3)	3(3–3)		
RANGE	1–5	2–5		
T24				
MEAN±SD	2.83±1.08	2.90±0.87	12.607	0.814
MEDIAN(IQR)	3(2–3)	3(3–3)		
RANGE	1–5	1–4		

p-value>0.05 NS; *p-value<0.05 S; **p-value<0.001 HS; Using:unpaired student t-test.

Based on the static VAS score at T base, T0, and all subsequent time points (T2, T4, T16, and T24), no statistically significant difference was seen between the two groups. As compared to PENG, the FICB group had higher values at T8, T12, and 3.06 vs. 2.41 and 3.90 vs. 3.06, respectively, with a p-value less than 0.05, (table 2; figure 4).

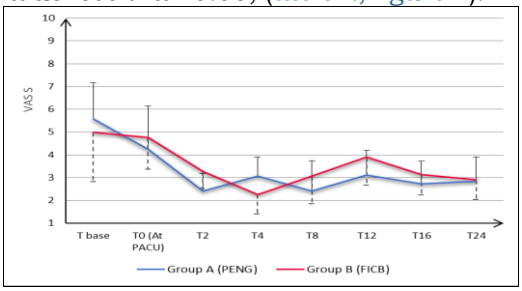

Figure 4. Comparison between studied groups according to static VAS score.

Table 3. A comparison of the groups that were studied using the dynamic VAS score.

VAS D	GROUP-A (PENG) (N=35)	GROUP-B (FICB) (N=35)	T-TEST VALUE	P-VALUE
T BASE				
MEAN±SD	6.19±1.49	6.43±1.55	0.680	0.496
MEDIAN(IQR)	6(5–7)	6(5–7)		
RANGE	4–10	4–10		
T2				
MEAN±SD	4.11±1.55	4.61±1.81	15.822	0.305
MEDIAN(IQR)	4(3–5)	4(4–6)		
RANGE	2–7	2–7		
T4				
MEAN±SD	3.11±1.51	3.57±1.66	13.206	0.016*
MEDIAN(IQR)	2(1–4)	2(2–4)		
RANGE	1–6	1–6		
T8				
MEAN±SD	3.85±1.55	4.17±1.38	15.411	0.517
MEDIAN(IQR)	4(3–5)	4(3–5)		
RANGE	2–8	2–7		
T12				
MEAN±SD	3.77±1.15	4.57±1.72	11.207	<0.001**
MEDIAN(IQR)	3(2–5)	4(3–5)		
RANGE	1–6	2–8		
T16				
MEAN±SD	3.61±1.29	3.82±1.17	13.158	0.392

MEDIAN(IQR)	2(2–3)	3(3–5)		
RANGE	1–7	1–6		
T24				
MEAN±SD	3.22±1.15	3.15±1.22	9.558	0.251
MEDIAN(IQR)	3(2–3)	3(3–5)		
RANGE	1–5	1–6		

p-value>0.05 NS; *p-value<0.05 S; **p-value<0.001 HS, Using; unpaired student t-test.

There was no a statistically significant difference between two groups according to dynamic VAS score at T base, T2 then at the rest of time points including T8, T16, T 24, Except at T4, T12 there was a statistically significant difference between two groups as The dynamic VAS score was lower in PENG group, compared to FICB group(3.11 vs. 3.57; 3.77 vs. 4.57) respectively p-value(p<0.05),(table 3; figure 5).

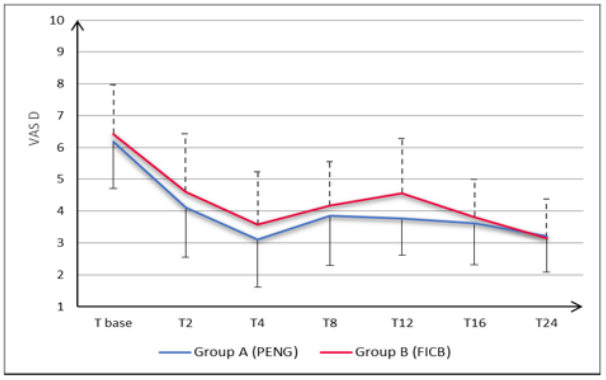

Figure 5. Comparison between studied groups according to dynamic VAS.

Table 4. Comparison between studied groups according to success rate and time to first postoperative analgesia (minutes) of nalbuphine.

TIME TO FIRST POSTOPERATIVE ANALGESIA (MINUTES) OF NALBUPHINE	GROUP-A (PENG) (N=35)	GROUP-B (FICB) (N=35)	T-TEST VALUE	P-VALUE
MEAN±SD	492.84±99.06	438.58±57.45	55.198	<0.001**
RANGE	381–611	362–571		
SUCCESS RATE N(%)	33(94.3)	32(91.4)	X2=12.47	0.759

**p-value<0.001 HS, Using:unpaired student t test and chi-square.

The groups were significantly different in terms of the time it took for the first dose of nalbuphine to be administered after surgery, measured in minutes, with a p-value of less than 0.001. Compared to group FICB, which had the lowest time (438.58 minutes), group PENG had the most time (492.84 minutes),(table 4; figure 6).

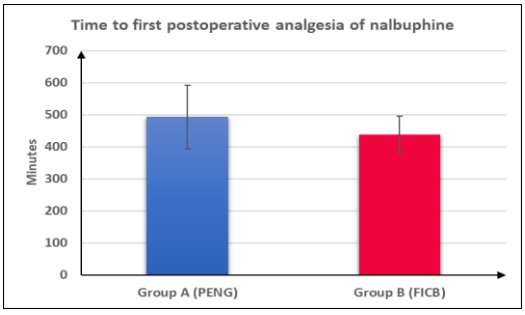

Figure 6. Time to initial nalbuphine postoperative analgesia compared across groups.

Table 5. Examination of the groups under study based on the cumulative 24-hour nalbuphine (mg) levels.

CUMULATIVE 24-HOUR NALBUPHINE CONSUMPTION (MG)	GROUP-A (PENG) (N=35)	GROUP-B (S-FICB) (N=35)	T-TEST VALUE	P-VALUE
MEAN±SD	6.6±2.76	9.07±2.69	2.23	0.036*

Using:unpaired student t-test.

Based on the cumulative nalbuphine consumption, the PENG group had a considerably lower value (p=0.036) compared to the FICP group,(table 5;f igure 7).

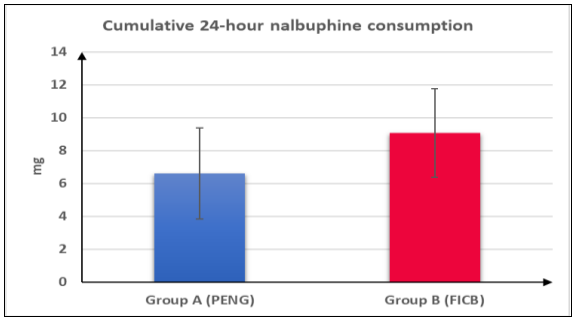

Figure 7. Intergroup comparison based on total 24-hour nalbuphine (mg).

4. Discussion

PENG block, which generates a sensory block while preserving quadriceps strength more effectively than FICB, has recently arisen as a viable substitute. For postoperative pain relief following hip surgery, a new peripheral nerve block called a PENG block can be utilized. There were a few changes from baseline, and it maintained motor strength while providing great pain relief around the hip joint.[5]

In the current study a 20ml of bupivacaine 0.25% was used based on Girón-Arango et al.,[4] On reviewing literature, it was showed that PENG block can be done by using different volumes (10-15-20-30)ml of bupivacaine 0.25%. In the initial description of this block, after 30 minutes of the block, five patients with hip fractures who had 20 mL of LA showed a marked decrease in pain scores. Much of what followed was an account of using a comparable volume.

Various writers use amounts ranging from 20 ml to 60 ml in their S-FICB. Considering this, 30 ml of bupivacaine 0.25% was utilized in this investigation. In FICB, the LA volume has a direct correlation with the analgesic duration. In most cases, people are given quantities ranging from 20 to 40 milliliters.

Numerous FICB-related studies have shown its usefulness in calming nervous patients before surgeries, especially in emergency rooms. There appears to be no established protocol for the application or volume dose of LA when the volumes used are investigated.

In another study by Yun et al.,[6] One group of patients with femoral neck fractures had

alfentanyl infusions administered to them, whereas another group had FICB injections of 30 mL of ropivacaine (3.75 mg/mL) 20 minutes before spinal anesthesia. They found that, in comparison to patients administered alfentanil, those who had FICB had significantly better postoperative pain relief and experienced no pain when situating for a spinal anesthetic.

Lopez et al.,[7] found that femur fracture patients who received a local injection of 20 mL of 1.5% lidocaine and 1/200,000 epinephrine, either at the scene of the injury or prior to hospital arrival, experienced excellent analgesia for a brief period of time.

A small LA volume won't be enough for this plane block, as we've learned from recent studies about the fascia iliaca's huge surface area. While this study found no benefit from a low LA volume, some writers have found success using lower volumes.

An investigation conducted by Monzon et al.,[8] In the emergency room, patients with hip fractures who had undergone the resistance loss procedure were administered FICB with 0.3mL/kg 0.25% bupivacaine.

It was noted that effective analgesia may be achieved for a maximum of eight hours prior to surgery. Researchers looked at people who had proximal femur fractures when they arrived at the hospital, Fujihara et al.,[9] pre- and postoperative analgesia with NSAIDs in one group and FICB with 10 mL of 0.75% ropivacaine and 10 mL of 2% mepivacaine in the other. Reports indicated that FICB reduced pain scores for up to 12 hours both before and after surgery. In contrast to the current study, the two aforementioned investigations used preoperative applications, meaning that surgical factors had not yet contributed to discomfort.

Time to first rescue analgesia demonstrated a statistically significant difference among both groups with respect to this outcome. Compared to the FICB group, it took more time in the PENG group (492.84±99.06 minutes) with a p-value of less than 0.001.

In keeping with our findings, Natrajan et al.,[10] who planned to operate on 24 patients' hips and conducted a randomized, double-blind, controlled trial. One group got a USG-guided PENG block, while the other got a USG-guided FIC block. The results demonstrated that the PENG block group required analgesics at a substantially later time than the FICB group. Specifically, the PENG block group required 8.17±3.129 minutes, whereas the FICB group required 4.00±1.477 minutes. The difference in latency was statistically significant (P=0.00).

Mosaffa et al.,[11] underwent a clinical investigation involving patients with hip fractures that was randomized and controlled. Both Group A (n=22) and Group B (n=30) were given a PENG block.

It was shown that the PENG block had a substantially longer duration for the first time analgesic consumption after surgery compared to the FCIB (4.7+3.1 vs. 2.58+2, p=0.007). That outcome demonstrated a considerably reduced duration to first opioid rescue analgesia. We found that paracetamol and ketolac need more time to first provide rescue analgesia; therefore, it's possible that the shorter time is due to not using regular dosages of these medications.

At 8 and 12 hours, the static VAS score was greater in the FICB group compared to PENG ($p<0.05$), as shown by the current results of the Static and Dynamic VAS scores. There was a statistically significant difference between the two groups at 4 and 12 hours in terms of dynamic VAS score, with the S-FICB group achieving higher scores than the PENG group.

Consistent with our findings, Lei et al.,[12] conducted a prospective, randomized controlled trial to assess the effect of continuous fluoracaine (FICB) and continuous propofol (PENG block) on postoperative pain after total hip arthroplasty. FICB used 30 milliliters of 0.25% ropivacaine, whereas the PENG block used 20 milliliters. Results showed that the PENG group had stronger affected-side quadriceps compared to the FICB group.

4. Conclusion

Postoperative exercise pain following hip surgery can be alleviated with a PENG block. Compared to the suprainguinal FICB, it reduced total opioid consumption after hip operations and increased the time to first rescue analgesia. Full hip range of motion preservation allows for easier early ambulation and allows for more strenuous joint rehabilitation training after surgery.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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