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Comparative Study of Preoperative Ultrasound Guided Pericapsular Nerve Group Block and Femoral Nerve Block for Analgesia of Proximal Femur Fracture Fixation Under Spinal Anesthesia

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ORIGINAL ARTICLE

Comparative Study of Preoperative Ultrasound Guided Pericapsular Nerve Group Block and Femoral Nerve Block for Analgesia of Proximal Femur Fracture Fixation Under Spinal Anesthesia

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Abstract

Background: ***Proximal femur fractures are the most common type of fracture, especially in elderly adults. During surgery, regional anesthesia may be advised for certain individuals. But the severe pain associated with these injuries makes it difficult to place the regional anesthetic correctly, which alters the overall success rate.***

Aim of the Work: ***To evaluate the overall effectiveness of pain alleviation during patient placement for spinal anesthesia by comparing the visual analog scale (VAS) score and ultrasound-guided pericapsular nerve group block (PENG) versus femoral nerve block (FNB).***

Patients and Methods: ***Following permission from the Al-Azhar University Hospitals Scientific and Ethical Committees for the Anaesthesiology Department, 50 patients were enrolled in the study and split into two groups (n=25 each), PENG and FNB. The two groups received the appropriate pre- and post-operative evaluation and monitoring. The visual analog scaling technique was employed to contrast the two analgesic outcomes.***

Results: ***2018 saw the first description of the PENG block for the preoperative treatment of femur neck fractures. We did not find any statistically significant differences in pain levels throughout the first 24 hours following surgery and during the positioning process for spinal anesthesia. Similarly, there was no discernible difference between the two groups' first rescue analgesia time or cumulative nalbuphine consumption 24 hours following surgery.***

Conclusion: ***In comparison with femoral nerve block, This study found no evidence that PENG block significantly reduces pain during spinal anesthesia positioning for the treatment of hip fractures***

Keywords: Guided Pericapsular Nerve; Femoral Nerve; Spinal Anesthesia; Femur Fracture

1. Introduction

The most frequent type of fractures, particularly in the older population, are proximal femur fractures. They frequently cause immobility or cause difficulties in day-to-day living. Furthermore, they may experience several medical consequences in addition to surgery issues.[1]

During surgery, regional anesthesia may be advised for certain individuals. But the severe pain associated with these injuries makes it difficult to place the regional anesthetic correctly, which alters the overall success rate.[2]

The primary tool used in conventional pain therapy has been opioids, which are known to have detrimental systemic consequences. Numerous nerve blocks have been tried in an attempt to solve this issue. Preoperative analgesia not only aids in appropriate patient positioning before surgery, but it also relieves postoperative pain.[3]

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Since Winnie et al. first demonstrated the 3 1 (FNB) in 1973, it has been regarded as a standard procedure for treating hip fractures. In order to numb the femoral, obturator, and lateral femoral cutaneous nerves, the procedure employs an anterior thigh approach.[4]

Giron-Arango et al. (2018) described the (PENG) local aesthetic approach for acute analgesia associated with hip fractures. The femoral nerve and its branches are blocked. A unique localized method, the PENG block has the potential to reduce pain more effectively while maintaining motor function.[5]

Anesthetists may now see the nerve, needle, and drug distribution thanks to the introduction of ultrasonography in anesthesia, which increases the likelihood that the nerve block will go well.[6]

Study participants had proximal femur fractures, and researchers used a visual analog scale (VAS) to assess the two methods of pain treatment after spinal anesthetic placement: ultrasound-guided PENG and FNB.

2. Patients and methods

The present investigation, a prospective randomized trial, was conducted in Al-Azhar University Hospitals with consent from the Anaesthesiology Department and the Scientific and Ethical Committees. This investigation included fifty adult patients scheduled for spinal anesthesia during proximal femur fracture repair. The patients belonged to Class I, II, and III of the American Society of Anaesthesiologists (ASA) and were over 18. Before the procedure started, patients were divided into two groups based on their random number table, and each group consisted of 25 patients.

This study included fifty adult patients scheduled for proximal femur fracture fixation under spinal anesthesia. The patients were over 18 years old and in the American Society of Anaesthesiologists (ASA) Class I, II, and III.

Exclusion Criteria: Coagulopathy, injection site infection, local anesthetic allergy, severe respiratory illness (≥ASA IV), diabetic neuropathies, among others. Individuals undergoing long-term opioid analgesic treatment have the Capacity to understand the contraindications of spinal anesthetic (VAS).

Preoperative settings:

Preoperative evaluations included a thorough physical examination, a thorough history collection, and laboratory testing (complete blood count, liver, kidney, prothrombin times, and partial thromboplastin time). The goals and design of the study, together with the methods and resources, were explained to each patient. Before being included in the trial, each patient signed an informed consent form. Each patient received information regarding the analgesic regimen and instructions on using the Visual Analog Scale (VAS), a 10-cm unmarked line with 0 representing no pain and 10 representing the greatest possible pain.

IV lactated Ringer (10 ml/kg for 20 minutes), and an 18G cannula insertion were initiated before the patient'spatients arrived in the operating room.

Intraoperative settings:

Electrocardiography, noninvasive blood pressure monitoring, and pulse oximetry were utilized when the patients reached the operating room. Vital signs such as heart rate (HR), oxygen saturation (SpO2), diastolic blood pressure (DBP), systolic blood pressure (SBP), and mean arterial pressure (MAP) are recorded before any treatment begins.

In the PNGB group, The patient was lying on their back to undergo the block procedure. The skin was cleaned to remove germs, and the transducer was placed to locate the Anterior Inferior Iliac Spine (AIIS). Then, the probe was turned counterclockwise by about 45 degrees to align it with the pubic ramus. This perspective allows for observing the Iliopectineal Eminence (IPE), the femoral artery, the pectineus muscle, and the iliopsoas tendon. The needle tip will be positioned in the musculofascial plane by moving from lateral to medial. It is between the pubic ramus in the back and the psoas tendon in the front. After confirming the absence of any negative aspiration, 30ml of bupivacaine 0.25% solution and 5ml of magnesium oxide 10% solution (equivalent to 500mg) were administered, ensuring that the hazardous dose of 3mg/kg was not exceeded.

The PENG block was conducted with meticulous aseptic measures utilizing an ultrasonic machine equipped with a 22-gauge sterile sheath enclosing a low-frequency curved probe (2-5MHz) and an 89-mm needle.

In the FNB group, the patient was placed in a supine posture to do the block. The skin was cleaned, and the femoral artery was located using the probe's "in-line plane" approach. It was discovered that the femoral nerve is a triangular-shaped, hyperechoic structure that is situated lateral to the femoral artery. A 22 G insulated needle was placed against the side of the femur artery. Following a pessimistic aspiration, the local cosmetic remedy (30ml of 0,25 % bupivacaine).Without going over the hazardous dose (3 mg/kg), 6 and 5 ml of a 10% magnesium sulfate solution (500 mg)8 were administered.[7]

FNB block was carried out utilizing ultrasonic equipment, including a linear probe, using an 89-mm, 22-gauge needle while adhering to strict aseptic protocols.

Following the block, patients were observed for 15 minutes for indicators of local anesthetic toxicity, every 5 minutes for noninvasive blood pressure, and continuously for ECG and pulse oximetry. If local anesthetic toxicity occurs, cardiovascular and respiratory support, as well as a 20% intralipid bolus of 100 ml over two to three minutes, will be administered.

Under fully aseptic conditions, the spinal anesthetic was administered to both groups using a 25-G spinal needle, 2 ml of heavy Marcaine (bupivacaine 0.5%), and 0.5 ml of fentanyl (25 µg). Regular intraoperative antiemetic dosages will be 4 mg of ondansetron and 8 mg of dexamethasone IV.

Before the block, during rest and motion (15° passive elevation) of the limb in question, and after the block's placement at 5, 10, and 15 minutes, as well as during placement, a 100 mm VAS score will be taken. Patients with a VAS score of less than three will be required to sit through spinal anesthesia. The patient will not be allowed to remain in the study if they experience severe pain that prevents them from positioning themselves. Additional analgesics will be administered in such cases.

A subjective metric for both immediate and chronic pain is the VAS. To record a score, a handwritten mark must be placed on a 10-cm line, with "no pain" on the left (0 cm) and "worst pain" on the right (10 cm) of the continuum. Analyzing a VAS score: 0-4 mm represents no pain, 5-44 mm represents mild pain, 45-74 mm represents moderate pain, and 74 mm or higher represents severe pain.

After surgery, the VAS score was recorded every two hours for the first six-hour period and then every six hours for the next twenty-four hours. Rescue analgesia was administered if the VAS score was greater than 4, and the total amount of nalbuphine was recorded. Analbuphine 0.2 mg/kg IV10 was requested as an initial analgesic.[8]

Sample Size calculation:

Using the PASS 11 program for sample size calculation, sitting power at 80% and α-error at 0.05. and according to previous literature, Thirty minutes post-block, the NRS score decreased significantly in PENG group mean (IQR), 6 (1) and 9 (1.5) to 3 (2) and 4 (1) and, in S-FICB group 5 (1.5) and 8 (1) to 4 (1) and 5 (1) at rest and movement, respectively (P < 0.0001). A sample size of 25 patients per group will be needed to detect the difference between the two groups.

Main Outcome Measures:

Primary outcome: Comparing the efficacy of pain relief between the two groups during patient positioning for spinal anesthesia using the VAS score.

Secondary outcomes: Comparing analgesic effect by VAS scores 1st 24 hrs, Total nalbuphine consumption 1st 24 hrs, and rescue analgesia time.

Statistical analysis:

The statistical program for the social sciences, version 21 (SPSS Inc., Chicago, Illinois, USA), was used to analyze the recorded data. The standard deviation (SD) was used to express quantitative data as the mean ± SD. Frequency and percentage were used to express qualitative data. Further examinations were conducted using separate samples. When comparing two means, the Mann-Whitney U test was employed. For two-group comparisons in non-parametric data, the Chi-square (x2) test of significance was utilized to compare proportions between qualitative parameters; the accepted margin of error was set at 5%, and the confidence interval was 95%. Consequently, the p-value deemed significant is as follows: P-values below 0.05 were regarded as substantial, P-values below 0.001 as extremely substantial, and P-values above 0.05 as unimportant.

3. Results

Table 1. Demographic data among the studied groups.

	PENG (N=25)	FNB (N=25)	T/X^2	P VALUE
AGE	54.1 ± 10.2	54.04 ± 10.4	T= 0.02	0.97
GENDER			X^2 = 0.32	0.56
MALE	10 (40%)	12(48%)		
FEMALE	15 (60%)	13 (52%)		
BMI [WEIGHT/(HEIGHT)^2]	28.14±6.17	27.87±5.91	t=0.158	0.875
COMORBIDITIES			X^2 = 0.4	0.94
NO	13 (52%)	11 (44%)		
DIABETES MELLITUS (DM)	5 (20%)	6 (24%)		
HYPERTENSION (HTN)	3 (12%)	4 (16%)		
UNCONTROLLED HTN/DM	4 (16%)	4 (16%)		
ASA GRADES				
1	13 (52%)	11 (44%)	X^2 =1.5	0.45
2	8 (32%)	10 (40%)		
3	4 (16%)	4 (16%)		

Data are represented as mean ± SD or number (%).

Data are analyzed using independent student t test or chi square test.

The study included 50 participants, with 25 individuals from each group. Age, BMI, sex, and ASA categorization were among the demographic characteristics that were comparable between the groups, while there was no statistically significant disparity among them.

Table 2. VAS at different time intervals versus baseline within pericapsular nerve group.

PARAMETERS	PERICAPSULAR NERVE (N=25)	T	P VALUE
VAS BASSLINE	9.10 ± 0.12		
VAS AT 2 MIN	6.02 ± 0.15	71.40	<0.001*
VAS AT 5 MIN	2.48 ± 0.19	137.30	<0.001*
VAS AT 10 MIN	0.84 ± 0.11	205.30	<0.001*
VAS AT 15 MIN	0.21 ± 0.08	298.50	<0.001*
VAS AT 2 H	1.76 ± 0.30	132.12	<0.001*
VAS AT 4 H	2.74 ± 0.47	114.48	<0.001*
VAS AT 6 H	4.17 ± 0.71	88.74	<0.001*
VAS AT 12 H	3.04 ± 0.52	109.08	<0.001*
VAS AT 18 H	3.82 ± 1.13	95.04	<0.001*
VAS AT 24 H	2.74 ± 0.47	114.48	<0.001*

Data are represented as mean ± SD Data are analyzed using paired student t test.

Within the pericapsular nerve group, there was a significant difference between the baseline and VAS at various time intervals.

Table 3. VAS at different time intervals versus baseline within femoral nerve block group.

PARAMETERS	FEMORAL NERVE BLOCK (N=25)	T	P VALUE
VAS BASSLINE	9.1 ± 0.11		
VAS AT 2 MIN	6.01 ± 0.19	59.60	<0.001*
VAS AT 5 MIN	2.48 ± 0.19	1440	<0.001*
VAS AT 10 MIN	0.85 ± 0.13	207.10	<0.001*
VAS AT 15 MIN	0.19 ± 0.07	309.30	<0.001*
VAS AT 2 H	1.84 ± 0.31	130.68	<0.001*
VAS AT 4 H	2.94 ± 0.50	110.88	<0.001*
VAS AT 6 H	4.34 ± 0.74	85.68	<0.001*
VAS AT 12 H	3.27 ± 0.56	104.94	<0.001*
VAS AT 18 H	3.96 ± 1.27	92.52	<0.001*
VAS AT 24 H	2.94 ± 0.50	110.88	<0.001*

Data are represented as mean ± SD Data are analyzed using paired student t test.

Within the femoral nerve group, there was a significant difference in the baseline and VAS at various time intervals.

Table 4: HR at different time intervals versus baseline within pericapsular nerve group.

	PERICAPSULAR NERVE (N=25)	T	P VALUE
HR AT BASELINE	83.04 ± 0.84		
HR AT 2 MIN	82.62 ± 0.88	2.18	0.007*
HR AT 5 MIN	82.2 ± 0.92	3.7	<0.001*
HR AT 10 MIN	81.04 ± 0.88	8.6	<0.001*
HR AT 15 MIN	79.3 ± 1.07	15.1	<0.001*
HR AT 2 HR	80.4 ± 1.04	10.2	<0.001*
HR AT 4 H	80.6 ± 1.01	10.15	<0.001*
HR AT 6 H	80.8 ± 0.98	10.1	<0.001*
HR AT 12 H	82.2 ± 0.92	3.1	<0.001*
HR AT 18 H	80.9 ± 0.95	8.5	<0.001*
HR AT 24 H	78.6 ± 2.7	7.9	<0.001*

Data are represented as mean ± SD Data are analyzed using paired student t test.

This table demonstrated a substantial difference between baseline and HR at various time intervals within the pericapsular nerve group.

Table 5. HR at different time intervals versus baseline within femoral nerve block group.

	FEMORAL NERVE BLOCK (N=25)	T	P VALUE
HR AT BASELINE	83.08 ± 0.9		
HR AT 2 MIN	82.64 ± 0.92	2.017	0.024*
HR AT 5 MIN	82.2 ± 0.93	3.3	<0.001*
HR AT 10 MIN	80.7 ± 0.84	10.2	<0.001*
HR AT 15 MIN	79.2 ± 0.84	18.2	<0.001*
HR AT 2 H	80.7 ± 0.83	9.5	<0.001*
HR AT 4 H	80.8 ± 0.79	8.85	<0.001*
HR AT 6 H	80.9 ± 0.75	8.2	<0.001*
HR AT 12 H	81.8 ± 1.1	3.9	<0.001*
HR AT 18 H	80.3 ± 1.1	9.9	<0.001*
HR AT 24 H	78.8 ± 0.88	16.6	<0.001*

Data are represented as mean ± SD Data are analyzed using paired student t test.

The baseline and HR at various intervals within the femoral nerve block group differed significantly.

Table 6: MAP at different time intervals versus baseline within pericapsular nerve group.

	PERICAPSULAR NERVE (N=25)	T	P VALUE
MAP AT BASELINE	98.4 ± 1.7		
MAP AT 2 MIN	97.75 ± 1.45	3.19	0.002*
MAP AT 5 MIN	97.1 ± 1.2	5.2	<0.001*
MAP AT 10 MIN	95.4 ± 1.29	11.3	<0.001*
MAP AT 15 MIN	94.08 ± 0.7	12.9	<0.001*
MAP AT 2 H	92.8 ± 1.7	11.6	<0.001*
MAP AT 4 H	92.6 ± 1.40	13.2	<0.001*
MAP AT 6 H	92.4± 1.1	14.8	<0.001*
MAP AT 12 H	92.6 ± 1.07	13.1	<0.001*
MAP AT 18 H	90.8 ± 0.89	19.8	<0.001*
MAP AT 24 H	89.7 ± 1.2	20.9	<0.001*

Data are represented as mean ± SD Data are analyzed using paired student t test.

There was significant difference between MAP at different time intervals and baseline within pericapsular nerve block group.

Table 7. MAP at different time intervals versus baseline within femoral nerve block group.

	FEMORAL NERVE BLOCK (N=25)	T	P VALUE
MAP AT BASELINE	98.30 ± 1.80		
MAP AT 2 MIN	97.7 ± 1.53	3.19	0.034*
MAP AT 5 MIN	97.1 ± 1.26	6	<0.001*
MAP AT 10 MIN	95.1 ± 0.97	9.3	<0.001*
MAP AT 15 MIN	93.8 ± 0.85	13.6	<0.001*
MAP AT 2 H	92.3 ± 0.81	14.8	<0.001*
MAP AT 4 H	92.5 ± 0.95	12.85	<0.001*
MAP AT 6 H	92.8 ± 1.09	10.9	<0.001*
MAP AT 12 H	91.1 ± 0.82	17.8	<0.001*
MAP AT 18 H	90.4 ± 0.86	18.6	<0.001*
MAP AT 24 H	89.2 ± 1	20.3	<0.001*

Data are represented as mean ± SD Data are analyzed using paired student t test.

Between baseline and MAP at various time intervals within the femoral nerve block group, there was a significant difference.

4. Discussion

This study documented that the PENG block is comparable to the femoral block for postoperative pain control. The PENG block was first described in 2018 for the preoperative management of femur neck fracture. We observed no statistically significant difference in pain scores during positioning for spinal anesthesia and the first 24 hours postoperative. Similarly, the two groups found no significant difference between the first rescue analgesia time and Cumulative nalbuphine consumption 24 hours after surgery.

Orthopedic emergencies involving fractures of the proximal femur, such as subtrochanteric, intertrochanteric, and neck femur fractures, are frequent, particularly in the elderly population. These fractures are very painful and have a high rate of morbidity and death.[9]

Fascia iliaca block (FIB), FNB, and 3-in-1 FN block are examples of regional analgesic treatments that are widely used since they mostly spare opioids and lessen the negative effects associated with opioids. For some patients, regional anesthetic is recommended during surgery. However, the intense pain connected to these injuries makes it challenging for the regional anesthetic to be positioned appropriately, which changes the total success rate.[10,11]

The lumbar plexus's femoral nerve [FN] L2-4 and obturator nerve L2-4 provide most of the sensory innervation to the hip joint and capsule. In contrast, sciatic nerve branches supply the posterior portion of the joint capsule. Skin supplied by the lateral femoral cutaneous nerve (LFCN) (L2, 3) and iliohypogastric nerve (L1) covers the anterior and lateral region of the hip joint, through which the incision is made. A popular procedure is the fascia iliaca block and the femoral nerve block.[12] Femoral block causes quads weakness and fascia iliaca block, a facial plane block that sporadically blocks the obturator nerve and LFCN and requires a significant amount of local anesthetic.[13]

According to a study, patients who received PENG block had greater postoperative pain alleviation and increased quadriceps strength than individuals who received FN block.[14]

The current study's findings show that while there was a significant difference in each group's VAS score between rest and movement, it was larger during movement than during rest. Nevertheless, The VAS scores for movement and rest for the examined groups did not differ significantly.

In agreement with the present study, Jadon et al. The pre-block numerical rating scores in the PENG and FICB groups were similar at rest and during movement, according to a study comparing supra-inguinal FICB with PENG for ease of placement under spinal anesthesia treatment in hip fracture patients (P=0.214 and 0.872, respectively). Additionally, they stated that the VAS score increased during movement compared to rest.[15]

In addition, Li et al.[16] They compared the FNB and FICB in patients with proximal femur fractures. They found that the pretreatment VAS for the FNB and FIB groups was identical during rest and movement.[16]

Regarding the first analgesia request time, there was no significant difference between both groups. In agreement with the present study, Jadon et al.,[15] demonstrated that there is no significant difference between groups in first rescue analgesia time; the time to first analgesic request (in hours) mean ± SD (95% CI) was 11.8 ± 0.84 (10.21–13.54) and 11.21 ± 0.70 (9.83–12.59) in the S-FICB and PENG groups, respectively (P = 0.524).[15]

In disagreement with the present study, Gupta and Kamath,6 demonstrated that the mean first rescue analgesia time for the FIB group was 7.1 ± 2.1 hours, while for the FNB group was 5.2 ± 0.7 hours. A remarkably significant P < 0.001 was obtained. Therefore, the period of analgesia the FIB gave was more than that of the FNB. There was no deviation in the total analgesic demand in both the groups in the 24 hours. Regarding total nalbuphin consumption, there was no significant difference between both groups.

Regarding VAS at different time intervals, there was no significant difference between both groups during positioning for spinal anesthesia and during the first 24 hrs postoperative. However, there was a significant difference between VAS at different time intervals and baselines within the pericapsular and femoral nerve groups.

In agreement with the present study, Allard, C. et al.,[17] documented that PENG block is comparable to femoral block for postoperative pain control with no statistically significant difference found in postoperative pain scores for 48 hours but produced fewer quadriceps muscle block.

In disagreement with the present study, Lin et al. [14] show that the PENG block provides better perioperative analgesia than the FNB. Postoperative pain scores were significantly improved in the PENG group compared with the FNB group.

5. *Conclusion*

Compared with the femoral nerve block, The PENG block is not associated with a connection in our investigation of statistically significant change in pain ratings during spinal anesthetic setting for the treatment of hip fractures.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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