Annals of Case Reports
Kimachi PP, et al. Ann Case Rep: 8: 1442
www.doi.org/10.29011/2574-7754.101442
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Research Article

Improved Functional Limitations and Decreased Pain in Preoperative Period after Pericapsular Nerve Group Block in Proximal Femoral Fractures

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Citation: Kimachi PP, Fernandes LCDL, Filho JV, Menezes NR, Matsumoto M, et al (2023) Improved Functional Limitations and Decreased Pain in Preoperative Period after Pericapsular Nerve Group Block in Proximal Femoral Fractures. Ann Case Report. 8: 1442. DOI:10.29011/2574-7754.101442

Received: 05 September 2023, **Accepted:** 09 September 2023, **Published:** 11 September 2023

Abstract

Background: Proximal femoral fractures commonly occur above 50 years and regional anesthesia could be a complement in the perioperative treatment of the patients. The use of pericapsular nerve group block (PENG Block) has been proposed to reduce pain. However, no studies have explored the efficient of the systemic analgesia associated with PENG Block in functional limitation in the preoperative period. In this sense, the main goal of this study was to evaluate the effectiveness of systemic analgesia associated with PENG Block in patients with proximal femoral fractures in the period preceding the surgical procedure. Focus on functional capacity measured by the Activity Measure for Post-Acute Care (AM-PAC) short version of the "6 Clicks", pain intensity assessed using the numerical rating scale, and opioid consumption.

Methods: This study included 21 patients admitted to the Emergency Room with proximal femoral fractures.

Results: There was an increase in the AM-PAC score obtained 12 hours after the PENG block compared to the pre-block evaluation; specifically, on turning over in bed; sitting down and getting up from a chair with arms; moving from lying on your back to sitting; moving from bed to chair and vice versa; and walking in the hospital room. Also, 1 and 12 hours after the PENG block there was a decreased in pain levels.

Conclusions: It is believed that the results of this study can guide the implementation of the PENG block in the preoperative period of fracture of the femur for reducing functional limitations and relieving pain, consequently, allowing the performance of diagnostic tests and guiding the surgical treatment.

Keywords: Pain; Proximal Femoral Fractures; Regional Anesthesia; Hip Arthroplasty; Functional Limitations; Pericapsular Nerve Group Block; PENG Block.

Introduction

Femoral fractures can be divided in proximal fractures (involving the neck, transtrochanteric), or diaphyseal fractures (occurring in the shaft of the femur [1]. This study focuses on proximal fractures involving the femoral neck and transtrochanteric fractures, which are more common in individuals above 50 years of age [2,3]. The most common mechanism that causes these fractures in older adults is falls from standing heights [4]. Proximal femur fractures can lead to severe pain and functional disability [5] associated with significant morbidity and mortality [6]. This lead to increasing costs to society, thereby reinforcing the importance of this study [1,7]. Additionally, this population, mostly older adults, may experience side effects with the use of potent analgesics. Regional anesthesia techniques are important complements to the perioperative treatment of patients undergoing hip surgery [8]. The PENG block is a promising technique that eliminates or minimizes pain in fractures of the proximal femur [9-12], and offers an adequate standard of analgesia and anesthesia for hip fractures [11]. However, the ability of the PENG block in fractures of the proximal femur to improve functional limitations in the preoperative period has not been evaluated. This study investigated the effectiveness of the PENG block associated with systemic analgesia in patients with proximal femoral fractures in the preoperative period, and focused on evaluating the functional impairment using the Activity Measure for Post-Acute Care (AM-PAC- "6 clicks"). The secondary goals were to evaluate the pain levels using the numeric rating scale before, 1 h, and 12 h after performing the PENG block, and opioid consumption 24 h after the preoperative period.

Methods

Trial design

This study comprised of 21 patients. The Ethics in Research Committee of the Hospital Sirio- Libanes/ Brazil Platform approved the project (CAAE 48721715.0.0000.5461), it is registered at ClinicalTrials.gov, Identifier: NCT05840458. All methods were performed in accordance with the relevant guidelines and regulations. The authors had no access to information that could identify individual participants during or after data collection.

Participants

All the study patients provided a written consent. Patients were recruited from July, 30th, 2021 to July, 1st, 2023. The main inclusion criteria were patients with unilateral proximal femoral fractures admitted to the emergency room of the Hospital Sírio-Libanes, aged 18-105 years, with the American Society of Anesthesiology (ASA) physical status I, II, or III. The exclusion criteria for enrollment in the clinical trial were previous allergy to metamizole and/or ropivacaine, history of mental disorders, and presence of chronic pain as assessed using the Douleur Neuropathique 4 (DN4) questionnaire [13].

PENG block

The PENG block was performed by a team of three experienced anesthetists. Prior to the procedure, a 2% chlorhexidine solution with 70% isopropyl alcohol and a sterile ultrasound-conducting gel were applied to the skin. A non-sterile conductive gel was applied to the face of the transducer. The operator wore sterile gloves, and a sterile cover was applied to the transducer. Before and after each procedure, the ultrasound apparatus was appropriately cleaned, disinfected with disinfectant wipes, and allowed to air dry [14]. This procedure was performed as described previously [9,10,12]. Briefly, the patient was placed in the supine position and the ultrasound probe was placed in the transverse plane over the anterior inferior iliac spine (AIIS) and aligned with the pubic ramus by rotating the probe counterclockwise by approximately 45 degrees. A 22-gauge, 100 mm needle was inserted using the plane approach from lateral to medial, between the psoas tendon anteriorly and the pubic ramus posteriorly. Following a negative aspiration, 20 mL of 0.375% ropivacaine was injected. The needle position was confirmed by visualizing the separation of layers with the dispersion of the injected volume. The Figures show the procedure before (Figure 1A) and after (Figure 1B) injection of the local anesthetic.

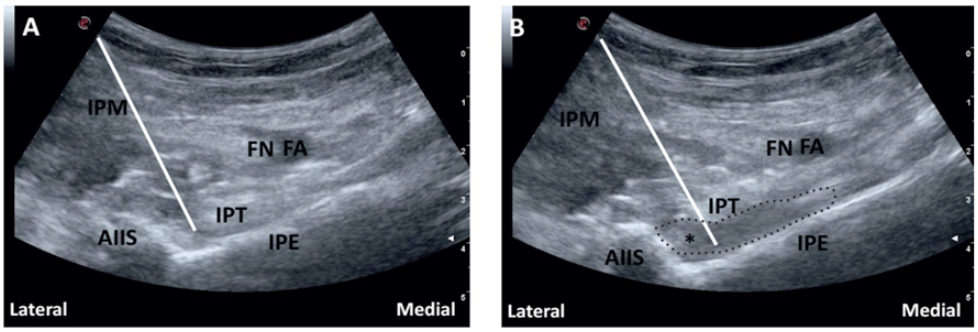

Figure 1: PENG block: A) before; and B) after the injection of 20 ml of local anesthetic below the iliopsoas tendon. It is possible to visualize the separation of layers with the dispersion of the injected volume, as showed in dashed black line.

AIIS: anterior inferior iliac spine; FA: femoral artery; FN: femoral nerve; IPE: iliopubic eminence; IPT: iliopsoas tendon; IPM: iliopsoas muscle; *: anesthetic dispersion; the white line corresponds to the needle path. PENG block: Pericapsular nerve group block.

Preoperative analgesia

All the patients received a standardized preoperative analgesic regimen consisting of metamizole (1 g every 6 h), tramadol (50–100 mg every 12 h), and intravenous morphine (2 mL) if numeric rating scale (NRS) ≥6.

1. Scales

The patients were interviewed using the following scales:

1.1. NRS is a standard scoring system ranging from 0 (no pain) to 10 (worst pain). The score was assessed as soon as the patient was admitted to the emergency room, and 1 and 12 h after performing the PENG block. The timeline choice was based on previous studies with the fascia iliaca [15] and PENG block [9].

1.2. Douleur Neuropathique 4 (DN-4) questionnaire consists of seven domains of neuropathic pain (burning, painful cold, electric shocks, tingling, pins and needles, numbness, and itching), and three domains related to sensory examination (hypoesthesia to touch, hypoesthesia to pinpricks, and pain caused by brushing) [16,13]. In this study, this scale was used for evaluation of exclusion criteria.

1.3. Short-form of Activity Measure for Post-Acute Care (AM-PAC- “6 clicks”) is a measure of basic patient mobility used in patients with hip fractures, that has high reliability among evaluators [17-19]. The items evaluated included bed mobility, sitting in a chair to stand position, moving to sit on the edge of the bed, transfer from bed to chair and vice versa, walking in the room, and going up 3–5 stairs [17,19]. The scores were evaluated immediately before and 12 h after the PENG block.

Additional data

Demographic and clinical data were collected.

Study design

All patients with proximal femoral fractures admitted to the emergency room were invited to participate in the study after providing written consent. In the initial assessment for inclusion in the study, the patients were interviewed using the NRS, neuropathic pain scale (DN-4), and AM-PAC- "6 clicks". Subsequently, the patients received a standardized preoperative analgesic regimen associated with the PENG block. Next, the pain intensity was assessed 1 and 12 h after this procedure. After 12 h, the AM-PAC- "6-clicks" was also evaluated. After 24 h, the total opioid consumption was recorded. Any intercurrent or adverse effects of analgesia were recorded during the study. The timeline of this study is shown in Figure 2.

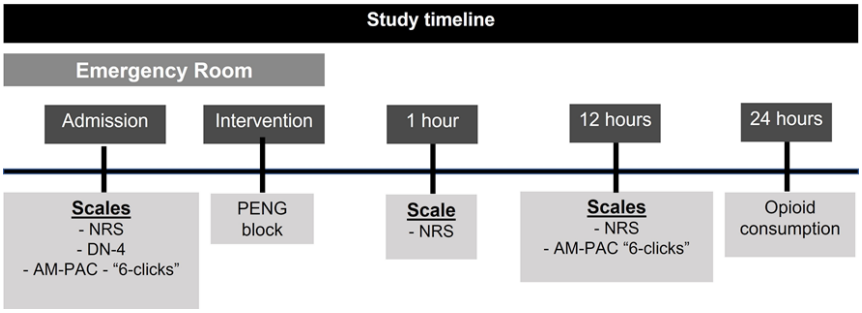

Figure 2: Study timeline. NRS: Numeric rating scale; DN-4: Douleur Neuropathique 4; AM-PAC- "6-clicks": short-form of activity measure for post-acute care; PENG block: pericapsular nerve group block.

Statistical methods

Statistical analyses were performed using the GraphPad Prism, version 9.0. Descriptive analysis of the collected demographic data, including the mean and standard deviation of the mean was performed. Categorical data were presented as absolute (N) and relative (%) frequencies. The Shapiro-Wilk test was used to evaluate the normalcy of data. Pain scores at several points were analyzed using repeated one-way ANOVA. AM-PAC- "6-clicks" data were analyzed using the student's t test for dependent measures. Statistical significance was set at $p < 0.05$.

Data availability

Data are available without restriction. All relevant data are within the manuscript and its supporting information files.

Results

Baseline data

Table 1 shows the demographic and clinical data of the patients included in this study. Data regarding age, height, and weight were presented as means and standard deviations. Data regarding comorbidities, continuous-use medications, and type of fractures are presented as the numbers (N) and percentage of patients.

Demographic data		
	Mean	Standard deviation
Age (years)	82,6	8,6
Height (cm)	164,0	6,4
Weight (kg)	64,1	12,2
Comorbidities		
	N	Percentage of patients
Systemic Arterial Hypertension	10	47,6
Coronary Insufficiency	2	9,5
Chronic Obstructive Pulmonary Disease	4	19,0

Dyslipidemia	7	33,3
Anxiety and Depressive disorders	2	9,5
Hypothyroidism	6	28,6
Osteoarthritis and Osteoporosis	2	9,5
Diabetes mellitus – type II	4	19,0
Other conditions	9	42,9
Continuous-use Medications		
	N	Percentage of patients
Anxiolytic	3	14,3
estatinasAntidepressive	3	14,3
Thyroid hormone replacement	6	28,6
Statins	6	28,6
Reflux	2	9,5
Antihypertensive	12	57,1
Antihyperuricemic	2	9,5
Bronchodilator	1	4,8
Anticoagulant	1	4,8
Antiosteolytic	1	4,8
Antipsychotic	1	4,8
Hypoglycemic agents	4	19,0
Antirheumatic	1	4,8
Antileukotriene	1	4,8
Antiparkinsonian	1	4,8
None	1	4,8
Type of fracture		
	N	Percentage of patients
Transtrochanteric	12	57,1
Femoral neck	9	42,9

Table 1: Demographic and clinical data. Descriptive analysis. N= number of patients.

Complications

No complications related to the nerve block procedure were reported. Additionally, no quadriceps weakness was clinically evident in any of the patients.

Primary outcome – functional capacity

After 12 h of the PENG block, there was a significant improvement ($t(1,20) = 10,1$; $p < 0.0001$) in the global score of AM-PAC-"6 clicks" compared with before the intervention, as shown in Figure 3A. Specifically, there was an improvement in the following: bed mobility ($t(1,20) = 9,3$; $p < 0.0001$), siting in the chair-to-stand position ($t(1,20) = 6,3$; $p < 0.0001$), moving to sit on the edge of the bed ($t(1,20) = 3,5$; $p = 0.002$), transfer from bed to chair and vice-versa ($t(1,20) = 5,3$; $p < 0 > 0.001$), walking in the room ($t(1,20) = 2,3$; $p = 0.03$), as shown in Figure 3B. There was no difference in climbing 3–5 stairs ($t(1,20) = 1, 4$; $p = 0>16$).

Secondary outcome - pain

There was a significant reduction in the NRS pain scores reported by the patients 1 and 12 h after the PENG block compared with before the intervention ($F(2,40) = 1,20$, $p < 0.0001$). Additionally, after 12 h there was a reduction in the NRS pain scores compared to 1 h after PENG block ($p = 0.0021$), as illustrated in Figure 3C.

Secondary outcome - analgesic medication

Figure 3D shows the numbers and percentages of patients who received metamizole, tramadol, or morphine. The mean amount (mg) of morphine used by patients per day was 0.43±0.75.

Time from admission to surgery

Figure 3E shows the time from admission to the surgical procedure. As it can be seen most patients had a surgery performed after 1 day of admission in the emergency room.

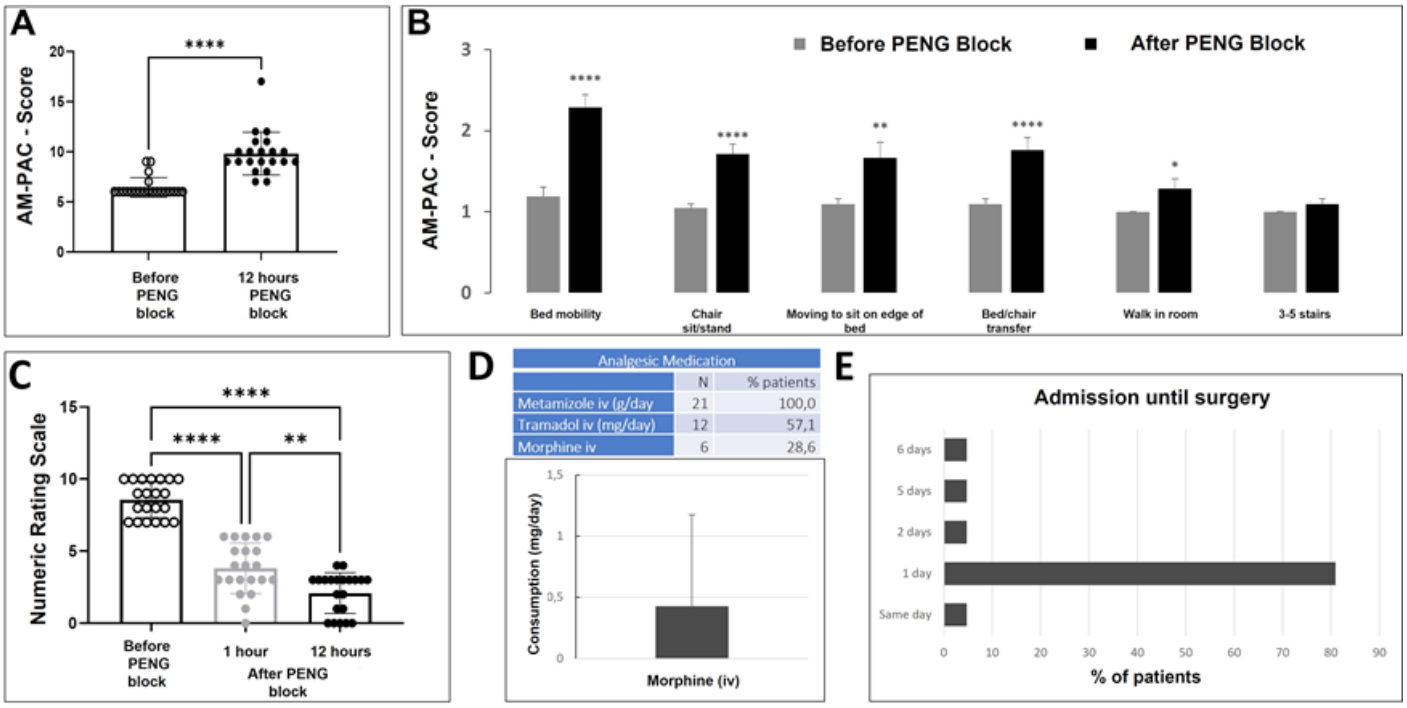

Figure 3: A) Total score obtained on the AM-PAC- "6 clicks" scale considering before, 1 and 12 h after the PENG block. Values are expressed as mean and standard deviation. The circles represent the individual score obtained on the scale. B) Score obtained on specific items of the AM-PAC- "6 clicks". C) Score obtained on NRS before, 1 and 12 h after the PENG block. Values are expressed as mean and standard deviation. The circles represent the individual score obtained on the scale. D) Analgesic medication considering number (N) and percentage (%) of patients that have used each of it and mean consumption of morphine. Values are expressed as mean and standard deviation. E) Percentage of patients distributed according to the time from admission to the emergency room until the surgical procedure was performed (N = 21). *: $p < 0.05$; **: $p < 0.005$; ****: $p < 0.0001$.

Discussion

To our knowledge, this is the first study to detailed evaluate the role of PENG block in functional capacity in the preoperative treatment of patients with proximal femoral fractures. The results showed that 12 h after the PENG block there was an improvement in basic mobility, including bed mobility, sitting in the chair-to-stand position, moving to sit on the edge of the bed, transferring from bed to chair and vice-versa, and walking in the room. Additionally, there was a reduction in pain scores 1 and 12 h after performing the PENG block. Annually, a significant proportion of patients are admitted to hospitals with femoral

fractures, which can lead to severe functional disability [5], and significant morbidity and mortality [6]. Those patients suffered substantial pain in the emergency care [20]. In this regard, the use of the PENG block is a promising technique, that promotes the reduction of pain in fractures of the proximal femur [9-12,21] to offer an adequate standard of analgesia and anesthesia for hip fractures [11]. Historically, the most commonly used nerve blocks in hip fractures include the lumbar plexus block, femoral nerve block, or iliac fascia block [22,6]. However, there was an incomplete analgesia of the hip, that could also predispose the patient to the risk of falling due to blockade of the motor branches, mainly of the quadriceps muscles, leading to a delay in mobilization and initiation of physical rehabilitation therapy [6,23]. The development of the PENG block is an important technical refinement that offers complete analgesia of the hip joint without blocking the muscle weakness [9-11]. This is a recent and promising blockade [9,10] that preserves the quadriceps motility of the operated limb in the immediate postoperative period, owing to the diffusion pattern of the blockade that reaches the anterior articular branches of the femoral, obturator, and accessory obturator nerves, excluding the motor branches of the femoral nerve, which are normally anesthetized by the femoral block, and are responsible for the motor innervation of the quadriceps [24,25]. There were no complications related to the nerve block procedure, as reported previously [26]. An important contribution of this study was the detailed assessment of the patients' functional capacity using the AM-PAC- "6-Clicks" scale. The results showed that 12 h after performing the PENG block, there was a significant improvement in basic mobilization. Most of the literature focus on the postoperative period. It has been proposed by Cochrane review studies that the use of regional anesthesia with nerve block in hip fractures decreases the initial time of patient mobilization [27,23] and reduces the time for the first mobilization of patients in the postoperative period [27]. It is important to highlight that the time required for mobilization varies depending on the type of block. It has been shown that only 13% of 30 patients who received a femoral nerve block had normal quadriceps motility 12 h after surgery, and more interestingly, 17% of these patients still had muscle weakness 24 h after surgery [28]. On the other hand, the PENG block enables preserved mobility in the immediate postoperative period of the operated limb, which could directly reduce the time for the first step and even the hospital length [24]. This preserved mobility could be explored in the context of a multimodal protocol for accelerating total postoperative recovery, which emerged from international multimodal protocols Enhanced Recovery After Surgery (ERAS), and has revolutionized the care of surgical patients [29]. This reinforces the importance of pain control as a crucial component of multimodal treatment [23]. In contrast to previous studies that evaluated the postoperative period, in our study the AM-PAC- "6 clicks" and the PENG block were evaluated preceding the surgical procedure. During this preoperative period, patients undergo a variety of diagnostic tests, including radiograph, CT, MRI, and evaluation of comorbidities, which require moving the patient in the emergency room, and sometimes moving from bed to the investigation table or surgical table30. In this regard, it was observed that the PENG block relieved the preoperative pain and consequently allowed patients to perform several activities, including turning over in bed, getting in and out of a chair with arms, moving from lying down to sitting position, moving from bed to chair, and vice versa, and walking around the hospital room prior to hip arthroplasty. This increased mobility could be seen 30 min after performing the PENG block and can be explained by the target focus on sensory innervation of the anteromedial capsule of the hip [23].

Thus, the main contribution of this study was to show that PENG block reduces the functional limitations resulting from the fracture of the femur, and thus allows the performance of all diagnostic tests, especially imaging tests. These are crucial to evaluate the location and classification of the fractures, consequently guiding the surgical treatment. In this context, the PENG block can be used preoperatively for hip surgeries, including pelvic and hip fractures [6,9,,31-39]. Routinely, drugs such as metamizole and tramadol are prescribed to reduce pain and minimize morphine consumption [40]. In this regard, our study showed that only 28.6% of patients used morphine to relieve pain. Most data on opioid consumption and PENG block were evaluated in the postoperative period. The PENG block has shown discrepant results, ranging from a significant reduction [41,42] to the absence of statistical differences in opioid consumption [25,43,44]. Furthermore, a recent meta-analysis showed that the PENG block decreased the morphine consumption in the first 24 h after the surgical procedure45. The probable mechanism responsible for the decrease in opioid consumption, considering the pre-and postoperative periods, could be the analgesic pattern provided by the PENG block [11]. Regarding our demographic data, the mean age was 82.6 years, occurred mainly in females, was located transtrochanterically, and in the femoral neck. Our data is in accordance with the literature that showed that the incidence of proximal femoral fractures increases after 50 years of age, which increases the risk factor for falls [46,47], and the greater percentage of patients are females [4,47]. Additionally, the patients included in the study had several chronic conditions that may be correlated with increased morbidity, worse physical functioning and quality of life, and increased anxiety and depressive disorders [48,49]. Among the comorbidities, the most common were hypertension, dyslipidemia, diabetes, and heart disease [50]. Regarding the management of proximal femur fractures, most patients included in our study underwent surgical procedures within the first 48 h after admission to the emergency room. This timing is important and is in accordance with best practices and better outcomes,

because surgical delay is associated with a significant increase in the risk of death and the appearance of pressure ulcers [51,52]. The limitation includes the design of a case-series study that does not include a control group; and not evaluating the outcomes in the postoperative period. In conclusion, our results suggest that the PENG block is a safe and feasible procedure that should be used in the perioperative period for proximal femoral fractures to reduce the functional limitations and relieve pain, thus enabling the performance of diagnostic tests and guidance of surgical treatment.

Declaration of Interests: The authors declare that this research was performed in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest. The authors declare no competing interests.

Ethical Statement: The Research Ethics Board of the Hospital Sirio-Libanes/ Brazil approved the study (CAAE 45968821.3.0000.5461) and registered at ClinicalTrials.gov, Identifier: NCT05840458. All methods were performed in accordance with the relevant guidelines and regulations.

Funding: The authors received no specific funding for this work.

Acknowledgements: The authors thank the research assistants and staff of the Hospital Sirio-Libanes (HSL), Emergency room, Anesthesia Medical Service (SMA) and Pain Management Center HSL.

Author contributions: Study design and data analysis: PPK, LCLF, JV, NRM, MM, ACPC, RLP, RCRM, GCP. Patient recruitment, data collection, and composition of the paper: PPK, LCLF, JV, NRM, MM, ACPC, GCI, CP, LLC, AR, TRP, CSC, EM, HVM, CVM, BAR, FGBZ, PST, RLP, RCRM, GCP.

Implication statement: Our study evaluated the use of pericapsular nerve group block (PENG block) in the preoperative period in proximal femoral fractures. PENG block improved functional limitations, reduced pain, allowing the diagnostic test, and guiding surgical treatment.

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