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Pericapsular nerve group block for analgesia of positioning pain during spinal anesthesia in hip fracture patients, a randomized controlled study

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ABSTRACT

Background: Spinal anesthesia has been favored by many anesthesiologists due to the simplicity of the technique, the lower incidence of complications like delirium and thromboembolic events. However, severe pain, encountered during positioning for spinal anesthesia, can complicate the technique and worsen the patient experience. Different regional blocks were employed to facilitate patient positioning for spinal anesthesia. Pericapsular nerve group (PENG) block is a recently regional technique based on blocking the articular branches to the hip joint. In our study, the PENG block was used for analgesia during positioning of patient with hip fractures for spinal anesthesia.

Methods: In this study, patients randomly divided into two groups, using closed envelope technique in blocks of 10; Control group (n = 30), and PENG group (n = 30). In the PENG group, the block was performed 30 minutes before spinal anesthesia, with the patient in the supine position using ultrasound guidance. Patient experience during positioning for spinal anesthesia was assessed and compared to the control group.

Results: The PENG block was associated with statistically significant lower pain levels (p 0.00), better patient sitting angle (p 0.00) during positioning for spinal anesthesia compared to the control group.

Conclusion: Preoperative PENG block is an effective option to control positioning related pain during spinal anesthesia, improved patient sitting angle, thus decreased the time required for spinal block and improved the anesthesiologist and patient experience.

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KEYWORDS
Hip fracture; positioning pain; PENG block; spinal; analgesia

1. Introduction

Proximal femur fractures are one of the commonest fractures especially in the elderly population. Early surgical fixation is the best analgesic for associated pain [1]. Spinal anesthesia has been favored by many anesthesiologists due to the simplicity of the technique, the better analgesic profile, and the lower incidence of complications like delirium and thromboembolic events [2–4]. However, severe pain, encountered during positioning for spinal anesthesia, can complicate the technique and worsen the patient experience. Different regional blocks were employed to facilitate patient positioning for spinal anesthesia including femoral nerve block (FNB), fascia iliaca compartment block (FICB), and lateral cutaneous nerve block (LCNB) [5–8].

Pericapsular nerve group (PENG) block is a recently regional technique based on blocking the articular branches to the hip joint with a single injection and is utilized for perioperative analgesia in hip surgery [9]. In our study, the PENG block will be conducted before patient transfer to the operating theater for spinal anesthesia. The primary outcome was the pain profile during positioning for the neuroaxial block. Secondary outcomes included the best angle obtained during patient positioning, time to CSF flow, patient experience (pain during positioning and sitting angle), and perioperative complications including quadratus muscle weakness, nausea, vomiting, shivering, and delirium.

2. Materials and methods

This prospective randomized blinded study was conducted in Mansoura University Hospitals, after approval of the institutional research board (R.20.1.721), and trial registry (PACTR202002906402947). Informed consents were obtained from patients scheduled for hip surgery under spinal anesthesia. Patients with bleeding tendency, local infection at the injection site, and difficulty to express pain scores were excluded from the study. The candidates were randomly divided into two groups, using closed envelope technique in blocks of 10; Control group (n = 30), and PENG group (n = 30) see Figure 1.

On arrival in the operating theater, automatic non-invasive blood pressure, electrocardiograph, and pulse oximetry were recorded and a wide bore cannula (18 G) was secured. In the PENG group, the block as

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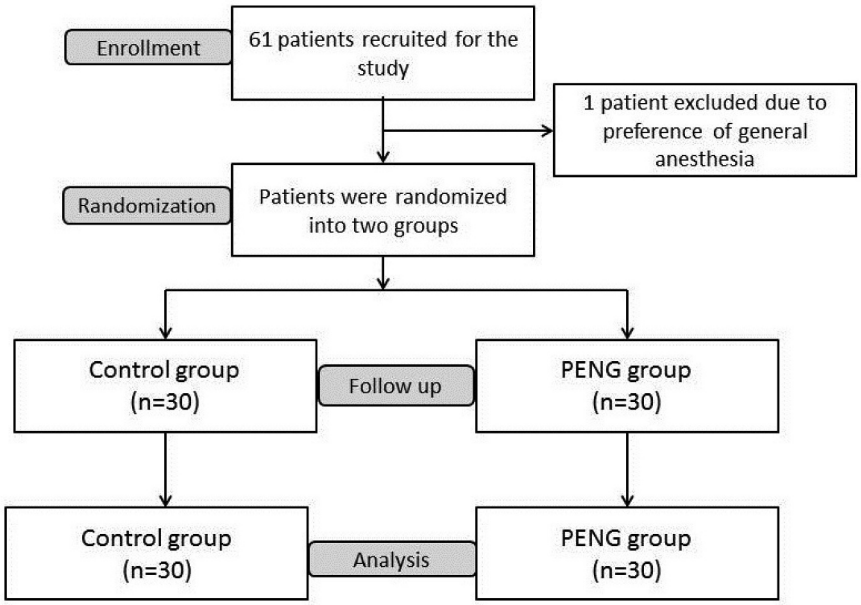

Figure 1. Study flow chart.

described by Girón-Arango et al. [10] was performed with the patient in the supine position using ultrasound guidance (high-frequency probe, L7M-A probe7.5 MHz, CHISON, Jiangsu, China). The probe was initially placed in a transverse plane over the anterior inferior iliac spine (AIIS), and then rotated 45 degrees anticlockwise to be roughly aligned with the pubic ramus. As shown in Figure 2, after keeping the iliopectineal imminence| (IPE), the iliopsoas muscle and tendon, the femoral artery, and pectineus muscle were maintained in the view, a 22-gauge, 80-mm needle was introduced from lateral to medial in an in-plane approach. When the tipoff the needle is visualized in the musculofascial plane between the psoas tendon anteriorly and the pubic ramus posteriorly, 20 ml of local anesthetic (LA) solution (bupivacaine 0.25%) was injected in 5-mL increments while observing for adequate fluid spread. Negative aspiration is performed at the start of the injection and after each 5 mls of the injectate. Patients arterial blood pressure and electrocardiographic tracings, respiratory rate, and pulse oximetry were evaluated noninvasively at 5 min intervals for 30 min after the injection. Also, patients were carefully observed to detect any symptom of LA toxicity of the anesthetic agent.

The control group was transferred to the O.R. table once the fluid preload was finished, while patients of the PENG group waited for 30 min after the block. Patients were helped to take a proper sitting position for spinal anesthesia. The spinal anesthesia technique was standardized for both groups. The attending anesthetist was blinded for the patient group.

Pain during positioning for spinal anesthesia was assessed and categorized into one of the following grades as modified from previous studies [6,11,12]; grade 1: Sitting without pain and with minimal help, grade 2: patient complains of mild pain detected by grimacing or verbal expression, grade 3: patient expresses severe pain but can tolerate positioning with help, grade 4: patient cannot tolerate positioning and required additional analgesia. Also, the best angle obtained by the patient during spinal anesthesia was

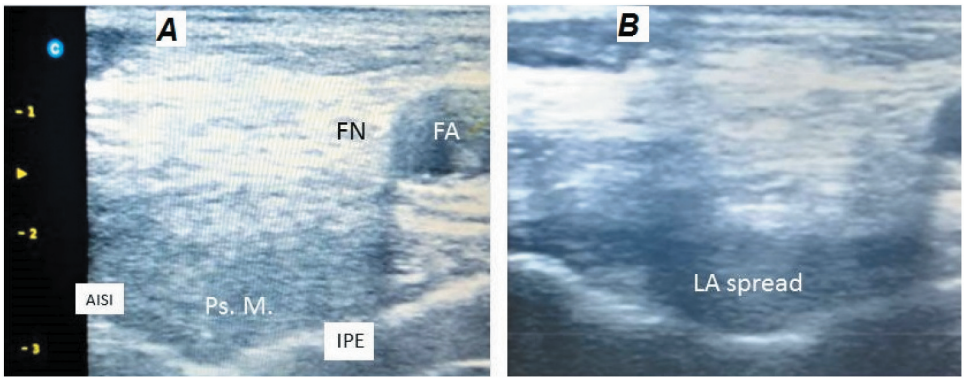

Figure 2. Ultrasound view showing land marks for the PENG block (A) and local anesthetic spread (B). FA: femoral artery, FN: femoral nerve, IPE: iliopectineal imminence, Ps.M: Psoas muscle and tendon, LA: local anesthetic.

classified into the following categories; A: Good flexion (angle more than 90), B: average flexion (angle less than 90) without twisting or using the hands for support, and C: Poor flexion and/or twisting or hand support. A member of the research team surveyed the anesthesiologists performing the block for operator satisfaction after the procedure (Excellent, Good, Average, and Poor). The time required by the anesthesiologist for a successful spinal injection and the number of trials were recorded. VAS will be monitored before and after PENG block and at the time of positioning for spinal anesthesia (i.e., 30 min after PENG block)

2.1. Sample size and study power calculation

G*power software version 3.1.9.4 was employed to compute the required sample size, using the data of a pilot study conducted among 10 patients, where patients given the PENG block had a lower pain score (mean decrease = 1.5) compared to the control group during positioning. A total sample size of 60 patients was sufficient to achieve a target study power of 95% power with an accepted level for alpha error of 0.05.

2.2. Statistical analysis

Perioperative data was tabulated and analyzed using IBM SPSS software version 22. Continuous data were presented as mean±SD or median (IQR) according to the normality of distribution. Nominal and categorical data were presented as numbers and percentages. Independent sample T-test, Mann-Whitney test, chi-square test, or Kruskal–Wallis test were applied to detect statistical differences between the study groups.

3. Results

In this study, 61 patients were assessed for eligibility criteria; one patient was excluded due to the preference of general anesthesia, see Figure 1. Demographic characteristics, preoperative laboratory data, medical history, and basal pain scores of the included patients are included in Table 1.

Table 1. Basal characteristics for the included patients in the two study groups. Data are presented as mean±SD, median (interquartile range).

	Control group n = 30	PENG group n = 30
Age (years)	57 ± 8	54 ± 11
Weight (Kg)	74 ± 13	72 ± 9
Height (cm)	167 ± 8	167 ± 6
BMI (kg/m^2)	25 ± 8	27 ± 5
Fracture age (days)	4(4)	4(8)
Basal VAS	5.5 ± 0.5	5.2 ± 0.8

BMI: body mass index, INR: international normalized ratio, DM: Diabetes Mellitus, HTN: Hypertension

Figure 3 shows a stacked column comparison between the pain levels during positioning for spinal anesthesia in the two study groups. The PENG block was associated with a statistically significant lower pain levels compared to the control group. Other spinal anesthesia trial outcomes are shown in Table 2. The PENG block was associated with a statistically significant better patient sitting angle during positioning for spinal anesthesia. The time required for CSF flow and the number of trials was lower in the PENG group when compared to the control group but did not reach statistical significance. Also, Anesthesiologist satisfaction was significantly higher in PENG group than in the control group.

Hemodynamic parameters for the study groups are compared in Figure 4. A significant decrease in the HR and MAP is noticed, reaching statistical significance at 30 min and after positioning for HR (p 0.03, p 0.02, respectively) and at 15 min after injection and after positioning for MAP (p 0.01, p 0.01, respectively) indicating lower pain scores and reduced stress response.

No perioperative complications including quadratus muscle weakness, nausea, vomiting, shivering, and delirium were recorded in the study groups.

4. Discussion

In this study, 60 patients scheduled for hip surgery under spinal anesthesia were included. Patient experience during positioning for spinal anesthesia was

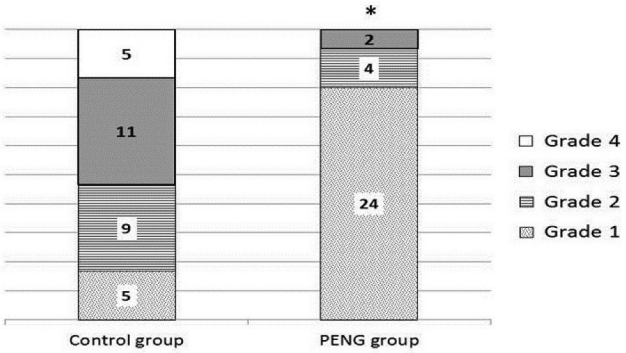

Figure 3. Pain profile expressed by the patients during positioning for spinal anesthesia. *P-value is significant if less than 0.05

Table 2. Spinal anesthesia trial outcomes in the two groups. Data are presented as mean±SD or n (%).

	Control n = 30	PENG n = 30	*P*
Time to CSF flow (sec)	38 ± 11	33 ± 8	0.08
Number of trials	1.2 ± 0.5	1.1 ± 0.3	0.43
Patient sitting angle n (%)			
• Good	1 (3%)	26 (87%)	
• Average	23 (77%)	3 (10%)	0.00*
• Poor	6 (20%)	1 (3%)	
Operator satisfaction n (%)	12 (40%)	27 (90%)	0.00*

CSF: cerebrospinal fluid, sec: seconds
**P* value is considered significant if less than 0.05

assessed; PENG block was associated with better patient experience and anesthetist satisfaction. Pain levels were lower in PENG group, which subsequently resulted in a better sitting position for neuroaxial procedure. Furthermore, the number of trials and the time required by the anesthesiologist to give spinal anesthesia were lower in the PENG group.

With proximal femur fractures, passive movement during positioning for spinal anesthesia can cause severe patient pain and discomfort [13]. One-third of the patients with a hip fracture will show signs of severe pain at rest, and the percentage increases to three quarters on movement and friction or overlapping of the fracture ends [14,15], this can negatively affect proper positioning for anesthesia [16,17].

Several strategies have been utilized to alleviate pain during positioning for spinal anesthesia including; NSAIDs, paracetamol, systemic opioids, and regional nerve blocks [18–21]. Since most hip fractures occur in the elderly population, associated comorbidities will complicate pharmacological approaches of pain management [18]. Opioids are associated with confusion, respiratory drive affection, and delayed mobilization. Also, NSAIDs can worsen the renal dysfunction that is reported in nearly 40% of these patients [13,22,23].

To reach an effective regional block, the sensory innervation of the hip joint was extensively studied [24]. The hip joint and the supero-anterior part of its capsule receives sensory innervation via articular branches of the femoral nerve (L2–4) and the obturator nerve (L2–4), while the posteroinferior capsule is innervated through branches of the sciatic nerve (L4–S3). Anesthesia for skin incision (the lateral cutaneous nerve of the thigh (L2, 3), and rarely, the lower thoracic cutaneous nerves) is out the scope of this study [10,24,25].

Increasingly, regional analgesia is encouraged to alleviate pain and decrease opioid requirements in the preoperative period. Also, regional blocks are considered as adjuncts for both general and neuroaxial anesthesia. In the context of positioning pain, regional nerve blocks, either as a single dose or continuously infusion, were administered via a variety of techniques (e.g., femoral nerve block [26,27], 3-in-1block [28,29], fascia iliaca block [30–32], and lumbar plexus block [33]).

However, none of the above-mentioned blocks is assumed to produce a perfect block for the hip joint. LPB is a deep block that is not preferred in patients with bleeding tendency and can be associated with serious complications like hematoma formation and renal trauma [22]. In FICB and 3in1 block, the LA extension is not always consistent, and sometimes the FN and the ON may not be covered. Additionally, in FNB, the articular branches that generate higher at L4 or 5 may not be blocked in the classic approach [17]. Similarly, the AON passes deep and medial to the psoas muscle at the level of L5. Moreover, weakness due to quadriceps femoris (QF) muscle involvement often impedes mobility in the immediate postoperative period and increases the fall risk [21,34,35].

In contrast to the above, PENG block targets the articular branches of FN and AON between the AIIS and IPE, while LA spread, also, to the subpectineal plane is assumed to block the branches of the ON

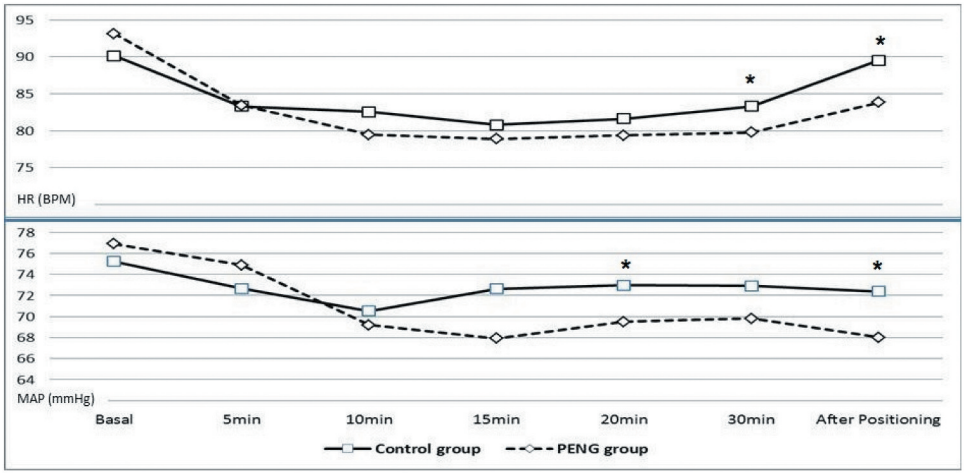

Figure 4. Hemodynamic parameters (HR, MAP) for the study groups before at admission to OR and at 5, 10, 15, 20, and 30 minutes after the block and immediately after positioning for spinal anesthesia. *P-value is significant if less than 0.05

[10]. Thus articular branches to the anterior capsule of the hip joint will be completely blocked using this approach.

In our results, the PENG block succeeds to reduce pain profile during positioning for spinal anesthesia, and this improved patient position. Our results are consistent with the results of previous case series. In the early report of the PENG block, the analgesic effect was superior with a mean reduction of the VAS scale by 7 points on the decimal scale [9]. Furthermore, the analgesic effect of the blocks was moderate with a mean decrease of 3.4 out of 10 in the VAS scale [36]. Also, In a recent report of five cases with the fractured hip joint, the PENG block succeeded to decrease pain levels at rest and during positioning for spinal anesthesia [37].

However, the PENG block will not relieve the pain related to the skin incision and subcutaneous dissection which is covered by the lateral cutaneous nerve. A combination of the LFCN block to PENG block was suggested to give a better form of analgesia than PENG block alone [38,39]. The scope of this study was to evaluate the preoperative analgesic effect of PENG block during positioning for anesthesia before the start of the skin incision. Also, complete anesthesia of the hip joint is assumed to require a sciatic nerve block, however, it is the anterior capsule that receives most of the sensory innervation of the jip joint [5,40].

Our study has some limitations. Catheter techniques and continuous blocks can provide the patient a pain-free whole perioperative journey [41], however, surgical fears of infections could not be alleviated. A future extension of the study protocol using Catheter technique is already planned in our center to assess the effect of continuous PENG block on postoperative analgesia after hip surgeries. Complete anesthesia of the hip joint is assumed to require a sciatic nerve block, however, it is the anterior capsule that receives most of the sensory innervation of the jip joint [5,40]. Time to spinal should have been measured starting from patient positioning on the OR table. The measurement from the start of the trial resulted in the omission of the time spent for positioning that is expected to be shorter in the PENG group due to lower pain levels. Additional time, required to assure full analgesic effect [5], can be compensated by proper coordination and earlier call for the recruited cases.

In conclusion, preoperative PENG block is an effective option to control positioning related pain during spinal anesthesia, improved patient sitting angle, thus decreased the time required for spinal block and improved the anesthesiologist and patient experience.

Disclosure statement

The authors report no conflict of interest.

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