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Comparative Study between PENG (Pericapsular Nerve Group Block) and Supra-Inguinal Fascia Iliaca Block (SIFIB) for Positioning and Post Operative Analgesia in Hip Arthroplasty Operations: A Prospective Randomized Comparative Clinical Study

Reda Khalil Kamel, Essam Fatouh Makram, Ahmed Aboelgheit Dawood and Nermeen Nabil Mohamed Leila *

Anesthesiology, Surgical Intensive Care and Pain Management Department,
Faculty of Medicine, Benha University, Benha, Egypt

***Corresponding Author:** Nermeen Nabil Mohamed Leila, **Email:** nermeennabil644@yahoo.com, **Phone:** 01060541416

ABSTRACT

Background: Effective pain management is crucial in hip arthroplasty for patient recovery and satisfaction.

Objective: This study aimed to compare the analgesic efficacy of ultrasound-guided pericapsular nerve group block (PENG) with supra-inguinal fascia iliaca block (SIFIB) for both intraoperative positioning and postoperative pain relief.

Subjects and Methods: A prospective, randomized, observer-blinded study at Benha University Hospitals. The study involved 60 patients who were scheduled for unilateral hip arthroplasty, divided equally to receive either PENG or SIFIB. The study assessed pain using the Visual Analogue Scale (VAS) at multiple post-block and postoperative intervals, time to first mobilization, morphine consumption, block failure rates, and patient satisfaction.

Results: The PENG group showed significantly lower VAS scores during positioning (2.96 ± 0.718 vs. 3.43 ± 6.26, p=0.01) and earlier mobilization (111.43 ± 12.23 min vs. 133.83 ± 21.99 min, p<0.001) compared to the SIFIB group respectively. There were no significant differences in postoperative VAS scores or morphine consumption between the groups. Patient satisfaction was higher in the PENG group (50% reporting good satisfaction vs. 26.7% in SIFIB, p=0.041).

Conclusion: PENG block provided better analgesia for patient positioning and facilitated earlier postoperative mobilization with higher satisfaction compared to SIFIB in hip arthroplasty patients. Both blocks were similarly effective for postoperative pain management.

Keywords: Pericapsular nerve group block, Ultrasound, Supra-inguinal Fascia iliaca block, Hip surgeries.

INTRODUCTION

Hip fractures frequently occur as an orthopedic complication after traumatic incidents in older adults [1]. Prompt and meticulous stabilization of these fractures is imperative to forestall the occurrence of fat embolism and additional sequelae associated with hip fractures. Anesthesia for the surgical rectification of these fractures is frequently administered through central neuraxial blockade, with spinal anesthesia being a prevalent method [2].

This methodology boasts numerous benefits in comparison with general anesthesia, including superior analgesia, enhanced early ambulation, diminished risk of deep vein thrombosis, and a notable reduction in morbidity and mortality rates [3].

Postoperative excruciating pain can significantly impede patient mobility, leading to an escalated utilization of intravenous analgesics along with its attendant adverse effects. Additionally, individuals suffering from hip fractures are typically of advanced age and possess various comorbid conditions, rendering the application of systemic analgesics less feasible. To ameliorate pain, enhance patient comfort, and augment the success rate of executing a subarachnoid block, regional analgesic strategies such as the femoral nerve (FN) block and the fascia iliaca block (FIB) are frequently employed [4, 5].

Nevertheless, the analgesic effect provided by these blocks is classified as moderate,[6] and evidence from the literature indicates that the articular branches of these nerves are blocked with inconsistency [7, 8]. Anatomical studies have documented that the articular branches of the femoral nerve, obturator nerve, and accessory obturator nerve (AON) innervate the anterior hip capsule. These can be effectively targeted by PENG block, as corroborated by references in the field [9, 10].

Consequently, this research aimed to evaluate the comparative analgesic effectiveness of ultrasound-guided PENG block versus SIFIB in facilitating intraoperative positioning and alleviating postoperative pain.

PATIENTS AND METHODS

This prospective, randomized, observer-blinded investigation was conducted at Benha University Hospitals on patients scheduled for unilateral hip arthroplasty.

Inclusion criteria: Age ≥ 18 years, of both genders and classified as ASA physical status I, II & III in the period between Nov. 2021 and Nov. 2022.

Exclusion criteria: Refusal to participate, disorders affecting blood clotting, hypersensitivity to local anesthetics or opioids, presence of infection at the intended site of the block, pronounced peripheral neuropathy or neurological conditions that impair lower limb function, possession of femoral grafts within the impacted limb, experiencing multiple traumas, challenges in understanding the VAS, communication

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impediments, undergoing bilateral hip arthroplasty or hip arthroplasty revision, ASA physical status exceeding III, a body mass index surpassing 35 kg/m^2, coagulopathy characterized by thrombocytopenia (platelet count below 100,000 per microliter), an international normalized ratio exceeding 1.5, engagement in therapeutic anticoagulation, or a history of opioid dependency.

These patients were randomized into two equal groups to receive either pericapsular nerve group block or fascia iliaca block. A web-based randomization application was utilized to produce a sequence of random numbers (http://www.randomizer.org/). The numerals assigned for the randomization of patients were discreetly encased in non-transparent envelopes, which were later accessed by the investigator conducting the study. Each participant was provided with a detailed explanation regarding the study's objectives and any unforeseen risks that might arise. Patients were randomized into two groups: **Group I (PENG):** Pericapsular nerve group block. Spinal anesthesia combined with Ultrasound guided pericapsular nerve group block and **group II (SIFIB):** Supra-inguinal Fascia iliaca block. Spinal anesthesia combined with Ultrasound guided fascia iliaca block.

Upon entering the operating theater, patients underwent a comprehensive assessment encompassing their medical history, clinical examination, and laboratory tests. Subsequently, automatic non-invasive blood pressure measurements, echocardiography, and pulse oximetry readings were meticulously documented. Additionally, a wide bore cannula (18G) was carefully established for vascular access.

Within the PENG cohort, the blockade procedure was executed with the patient positioned supine on the intended side of the surgical intervention precursor to the administration of spinal anesthesia by approximately 30 minutes. Utilizing an 80 mm 22G needle, the procedure was conducted under the surveillance of a Linear high-frequency ultrasound probe (7–15 MHz). Prior to the procedure, the skin was sterilized using a 7% betadine solution. The Linear high-frequency probe was initially positioned in a transverse orientation over the anterior inferior iliac spine (AIIS) and subsequently adjusted to align with the pubic ramus by rotating the probe counterclockwise around 45 degrees. In this specific ultrasonographic perspective, the ilio-pubic eminence (IPE), iliopsoas muscle and tendon, femoral artery, and iliacus muscle were discernible. Following the administration of 2 ml of 2% lidocaine for local anesthetic purposes, a 22-G needle was inserted in a lateral to medial direction employing an in-plane technique to accurately position the tip within the musculofascial plane situated anteriorly to the psoas tendon and posteriorly to the pubic ramus. Upon confirming negative aspiration for blood, a volume of 25 ml bupivacaine at a concentration of 0.25% was injected.

In the SIFIB group, the block was performed with patient in supine position on the proposed site of operation. A linear high-frequency ultrasound probe was meticulously positioned in the sagittal orientation to capture a clear image of the Anterior Superior Iliac Spine (ASIS). Subsequently, the probe was shifted medially to delineate the fascia iliaca, sartorius, iliopsoas, and internal oblique muscles. Upon the visualization of the distinctive 'bowtie sign,' indicative of the convergence of muscle fasciae, an initial administration of 2 ml of 2% lidocaine was undertaken for the purpose of local anesthesia. Following this, a 22-gauge, 80-mm needle was introduced with precision using an in-plane technique, positioned 1 cm cephalad to the inguinal ligament, aiming to situate the needle's tip beneath the fascia iliaca. A total volume of 25 mL of 0.25% bupivacaine was slowly injected after negative aspiration every 5-mL.

The accuracy of the needle's positioning was verified through the observable detachment of the fascia iliaca from the underlying iliacus muscle. The needle was then meticulously advanced within this delineated space, moving in a cranial and marginally dorsal trajectory. The deep circumflex artery, situated superficially to the fascia iliaca, serves as a critical anatomical landmark; its upward displacement upon injection acts as an indicative marker of successful fascia iliaca penetration.

All patients received spinal anesthesia, which was performed in sitting position after block was given. After aseptic preparation and the skin infiltration with 2% lidocaine. With 25 G spinal needle inserted at L3-L4 or L4-L5 intervertebral space using the midline or paramedian approach. After clear free flow of cerebrospinal fluid, 17.5 mg 0.5% hyperbaric bupivacaine and 25 mic fentanyl was injected intrathecally over 20-30 sec. and this technique was done for the two groups. The attending anesthesiologist was blinded for the patient group.

Within both cohorts, the discomfort experienced by patients during the arrangement for spinal anesthesia was evaluated and classified into distinct tiers as follows:

- **Grade 1** entailed the ability to sit without experiencing pain, requiring only minimal assistance.
- **Grade 2** was characterized by the patient reporting mild discomfort, as evidenced by facial grimacing or verbal articulation.
- **Grade 3** involved the patient conveying intense pain, yet managing to endure the positioning with support. **Grade 4** signified an intolerance to positioning by the patient, necessitating supplementary analgesic intervention. Patients were familiarized with the Visual Analogue Scale Score (VAS) identifying 0 as no pain and 10 as the worst pain.

The following data were recorded:

1. **Demographic data:** age, sex, weight, ASA classification & duration of surgery.
2. **VAS score before performing the block** was noted both at rest (baseline and 30 min after block) and during dynamic hip movement (Elevating the affected limb 15 degree above the table) (baseline and 30 min after block). VAS score also was noted at the time of positioning for spinal anaesthesia. Postoperative pain was assessed using 10 cm marked VAS where zero means no pain and ten means severe pain. Pain was assessed at PACU, 2, 4, 6, 8 12, 16 & 24 hours after operation. Patients with VAS score ≥ 3 during the first postoperative day were given 3 mg morphine intravenous as rescue analgesia, starting in the postoperative ward and for 24 hours postoperatively.
3. **Vital signs:** Mean arterial blood pressure (mmHg), heart rate (beats/minute) were monitored every 15 min for 1 h intraoperatively, at recovery room, at 15, 30, 45, 60 & 24 hours postoperatively.
4. **Time of administration of first rescue analgesia.**
5. **Postoperative analgesia was assessed by total doses of rescue opioid consumption.**
6. **Time to 1st mobilization (min.)**.
7. **Any undesirable side effects** during the time of the study were recorded (Manifestations of local Anesthetic toxicity, intravascular injection, and hematoma, hypersensitivity to local anesthesia or opioids**).**
8. **The failure rate of the block** was determined based on the criterion that a block was deemed unsuccessful if the patient necessitated more than two administrations of rescue analgesia within the initial postoperative hour.
9. Patient contentment regarding the efficacy of the block and the relief from postoperative pain was gauged using an 11-point satisfaction scale, where 0 signifies dissatisfaction and 10 represents the highest level of satisfaction. This scale was further segmented into categories: scores ranging from 0 to 3 indicated dissatisfaction, scores from 4 to 6 denoted a fair level of satisfaction, and scores from 7 to 10 were considered indicative of good satisfaction.

Ethical considerations

The study was done after being accepted by The Research Ethics Committee, Benha University (approval code: MD8-10-2021). All patients provided written informed consents prior to their enrolment. The consent form explicitly outlined their agreement to participate in the study and for the publication of data, ensuring protection of their confidentiality and privacy. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

Data assimilation was conducted via computational means, subsequently undergoing rigorous analysis through the deployment of the IBM SPSS statistical software, version 25.0, domiciled in Armonk, NY by IBM Corporation. The articulation of qualitative datasets was achieved through enumeration and percentage delineation, with analytical scrutiny facilitated via the employment of Chi-square methodologies or Fisher's exact test contingent upon the data's characteristics. The evaluation of data distribution's adherence to normalcy was systematically executed utilizing the Kolmogorov-Smirnov assessment. Quantitative datasets were elucidated by demarcating their spectrum (encompassing both nadir and zenith values), alongside the computation of arithmetic mean and standard deviation or median values supplemented with the IQR for a more nuanced data representation. The discernment of statistical disparities between the cohorts under examination was effectuated through the application of either the independent sample t-test or the Mann-Whitney U test, predicated on the data's distributional properties. The adjudication of the derived results' significance was established with a predilection for a 5% level of statistical significance.

RESULTS

Within the scope of this investigation, a total of 75 individuals were evaluated for their suitability to participate. Of these, 10 individuals were disqualified based on predefined exclusion criteria, while an additional 5 individuals opted not to partake in the research endeavor. Consequently, the residual cohort of 60 participants were methodically distributed via a randomization process into two distinct groups, each comprising 30 subjects. The entirety of this participant pool, encompassing all 60 individuals, was subsequently subjected to rigorous follow-up procedures and comprehensive statistical analysis (Figure 1).

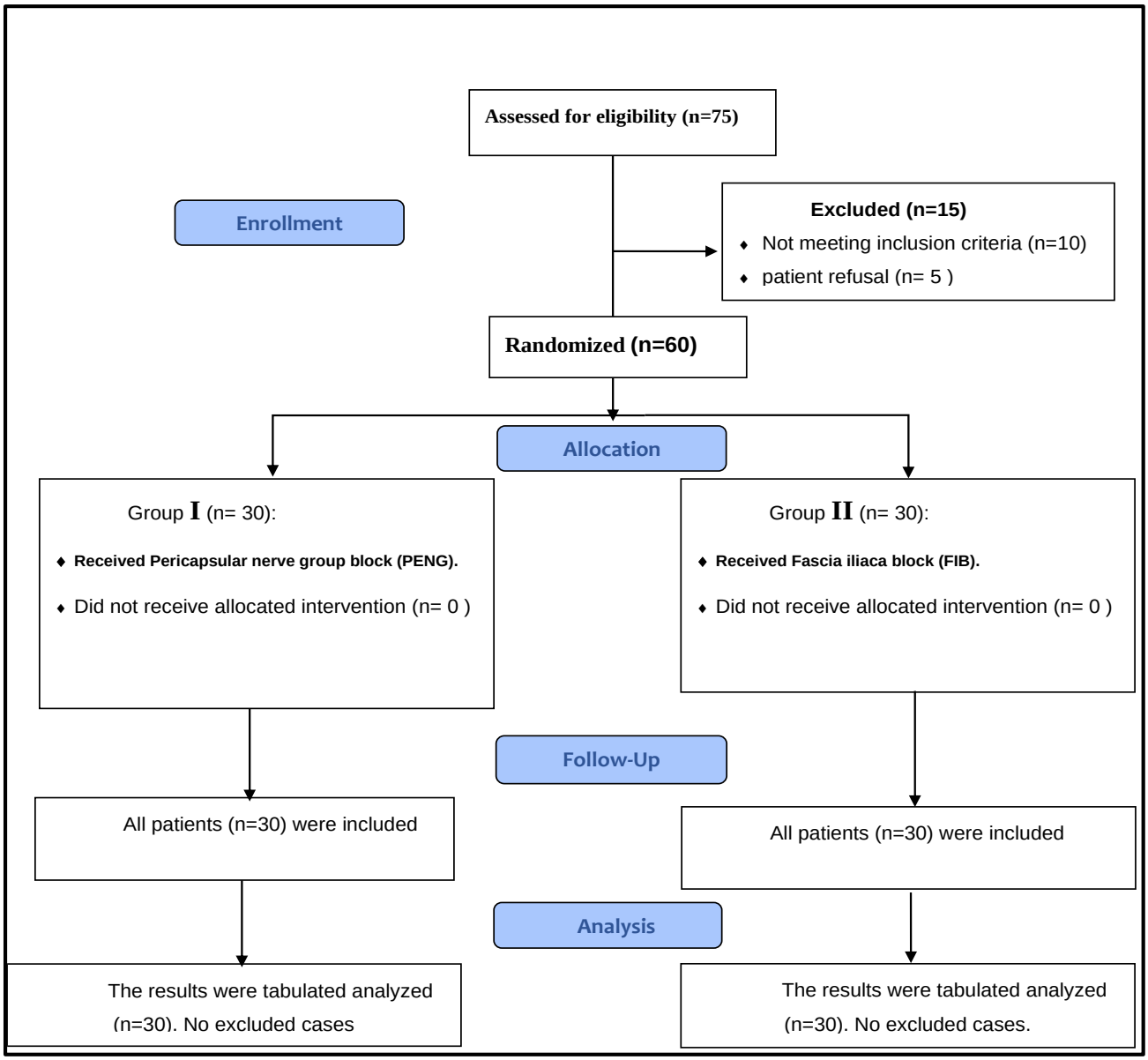

Figure (1): CONSORT flowchart of the studied groups.

As seen in table (1), there was no statistically significant difference between groups regarding demographic characteristics, and time of surgery.

Table (1): Demographic characteristics and time of surgery

		Group PENG	Group SIFIB	*p*-value
Age (yrs.)		51.67±15.078	51.97±15.46	0.94
Sex	♂	15(30%)	19(63.3%)	0.435
	♀	15(30%)	11(36.7%)	
Weight (Kg)		78.03±8.385	76.2±6.697	0.353
ASA	**I**	7(23.3%)	8(26.7%)	0.5
	II	19(63.3)	15(50%)	
	III	4(13.4%)	7(23.3%)	
Time of surgery (min.)		158.33±19.841	162.33±16.33	0.397

Data are presented as mean ±SD and number (%).

As seen in table (2), there was statistically significant decrease in VAS in group 1 than in group 2 (30 after block at rest and during dynamic hip movement) (p values = (0.014, 0.009) and during positioning for spinal anesthesia (p value=0.01) while there was no statistically significant difference in both groups postoperatively.

Table (2): VAS score

	Group PENG	Group SIFIB	*p*-value
VAS baseline at rest	**3.53±0.571**	**3.53±0.571**	**1.000**
VAS baseline during dynamic hip movement	**4.43±0.504**	**4.40±0.498**	**0.795**
VAS 30 after block at rest	**2.07±0.691**	**2.53±0.73**	**0.014***
VAS 30 after block during dynamic hip movement	**2.07±0.7**	**2.67±0.994**	**0.009***
VAS during positioning	**2.96±0.718**	**3.43±6.26**	**0.01***
VAS recovery	**2.13±0.629**	**2.03±0.615**	**0.528**
VAS 2 hrs.	**2.20±0.610**	**2.13±0.681**	**0.727**
VAS 4hrs.	**2.23±0.626**	**2.33±0.606**	**0.537**
VAS 6hrs.	**2.87±0.973**	**2.80±0.997**	**0.804**
VAS 8 hrs.	**2.5±0.682**	**2.77±0.858**	**0.294**
VAS 12 hrs.	**3.43±0.898**	**3.57±1.135**	**0.44**
VAS 16hrs.	**2.30±0.535**	**2.17±0.379**	**0.229**
VAS 24 hrs.	**2.33±0.547**	**2.2±0.407**	**0.242**

As seen in table (3), there was non-significant differences between groups regarding morphine consumption, time to 1st analgesic request, failed block, and complications while there was a significant difference between both groups regarding time to 1st mobilization (p= 0.001) and patient satisfaction (p= 0.041) in favor of group PENG.

Table (3): Comparison between two groups according to

		Group PENG	Group SIFIB	*p*-value
Morphine consumption		2.3410 ± 0.251	2.286 ± 0.2	0.353
Time to 1st analgesic request (hrs.)		10.07 ± 2.803	10.4 ± 2.541	0.631
Time to 1st mobilization (min.)		111.43±12.23	133.83 ± 21.99	<0.001
Failed block	**Yes**	2 (6.7%)	3 (10%)	1
	No	28 (93.3)	27 (90%)	
Patient satisfaction	**Unsatisfied**	0	4 (13.3)	0.041
	Fair	15 (50%)	18(60%)	
	Good	15 (50%)	8 (26.7)	
Complications	**No**	30 (100%)	29 (96.7)	1
	hematoma	0	1 (3.3%)	

As seen in figure (2 & 3), There was statistically non-significant difference between the two groups regarding hemodynamics.

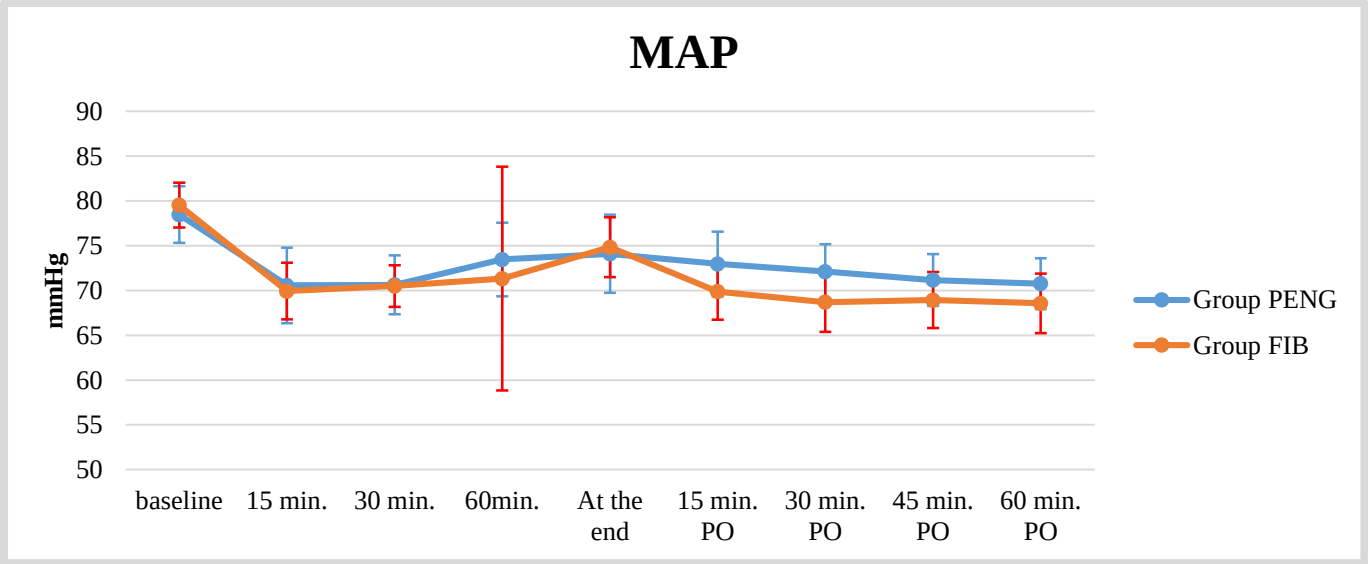

Figure (2): Mean arterial pressure (Intraoperative, postoperative).

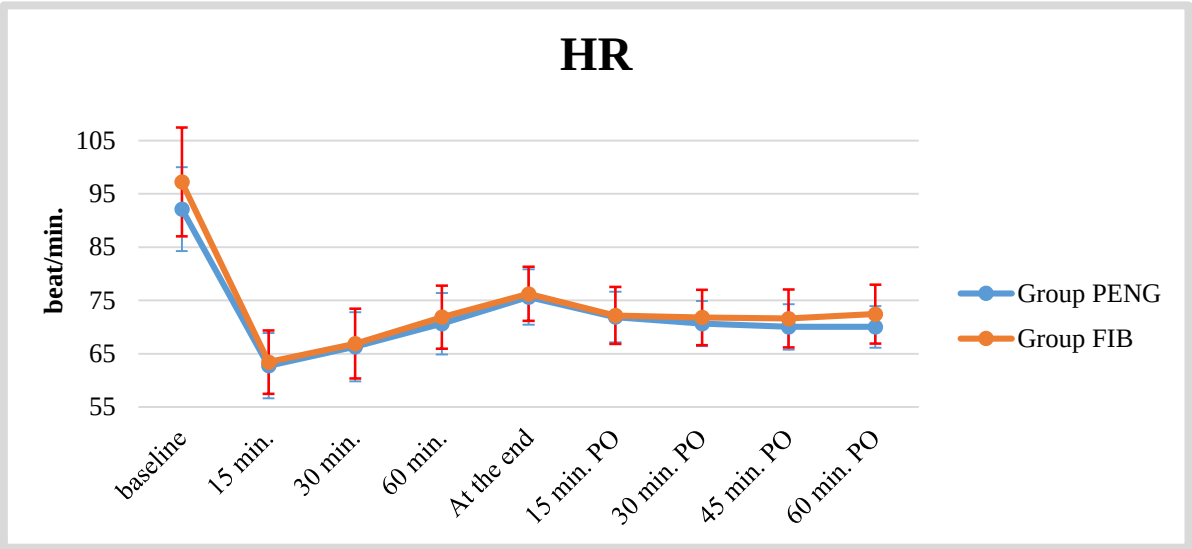

Figure (3): Heart rate (Intraoperative and postoperative).

DISCUSSION

PENG block was associated with less pain during positioning and better patient satisfaction than fascia iliaca block. In the context of our research, the empirical evidence revealed that both cohorts maintained hemodynamic stability, with no noteworthy disparities in heart rate and blood pressure metrics observed between them. This observation aligns with the findings of **Shankar *et al.*** [11] who reported that in comparison with SIFIB, there were no statistically significant variations in the heart rate and mean arterial blood pressure values throughout the duration of the postoperative period. **Alrefaey *et al.*** [12] elucidated that, in instances of hip fractures, PENG block affords more effective analgesia in comparison with SIFIB during the process of positioning (specifically sitting) for spinal anesthesia. This conclusion resonates with the observations recorded in our own investigation.

Regarding the assessment of pain scores, the analysis revealed no statistically significant difference between the two groups under study in terms of the baseline VAS scores at rest, during dynamic hip movement, at recovery, and at intervals of 2, 4, 6, 8, 12, 16, and 24 hours postoperatively. However, a statistically significant reduction in VAS scores was observed 30 minutes after the administration of the block at rest, during dynamic hip movements, and during positioning specifically within PENG cohort. Our results are in agreement with findings of **Shankar *et al.*** [11], confirmed that there was statistically non-significant differences in drug requirements in patients undergoing hip surgeries. **Hao *et al.*** [13] found that compared to FIB, PENG block was more effective in analgesia, it facilitated positioning of the patients with fracture neck femur undergoing hip arthroplasty before anesthesia, thus provided good sensory relief with preserving the quadriceps motor function. Our results and the findings of **Hao *et al.*** [13] confirm the advantage of lower pain score during positioning and motor sparing for postoperative early mobilization.

Total hip arthroplasty (THA) ranks among the most frequently performed significant surgical interventions, serving as an efficient and economically viable measure that notably enhances the health-related quality of life and functional capacity of patients [14]. Pain experienced in the aftermath of THA can detrimentally impact the early phase of postoperative patient recuperation, elevating the likelihood of developing venous thromboembolic conditions and potentially hindering the rehabilitation process [15]. The repercussions of postoperative pain, including extended hospital stays and escalated costs, underscore the importance of effective pain management following THA. Prioritizing adequate pain control post-surgery is crucial for improving patient well-being and mitigating the physiological effects associated with pain [16].

Regional anesthesia is deemed a pivotal element within the framework of multimodal general anesthesia (MGA), attributed to its capacity to attenuate the surgical stress response and diminish the reliance on opioids, thereby curtailing their adverse side effects by providing superior analgesic efficacy [11].

The study, while informative, is limited by its single-center design, suggesting a need for multicenter trials to validate the findings. Additionally, the use of catheter techniques for continuous blocks, potentially offering a pain-free perioperative experience, was not explored due to concerns over infection risks, thereby precluding the assessment of continuous PENG block catheters against other catheter-based techniques. Furthermore, the time required to perform the

blocks was a point of contention among surgeons. It is recommended that future studies investigate the potential benefits of PENG and SIFIB blocks within postoperative clinical pathways for patients undergoing THA, to better understand their effectiveness and efficiency in clinical practice.

CONCLUSION

PENG block was effective as SIFIB for perioperative analgesia in patients undergoing THA reducing total opioid consumption and delay first time to rescue analgesia with insignificant difference between both groups. While the hemodynamic stability was insignificant between both groups. Also, there was significant difference between both groups regarding pain during positioning for anaesthesia, first time of mobilization and patient satisfaction for the sake of PENG block.

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