













Research Article

Pericapsular Nervous Group Block versus Suprainguinal Fascia Iliaca Block Using the Same Injection Volume in Primary HIP Arthroplasty Prospective Observational Study

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Objectives. To determine the pericapsular nerve group (PENG) block's postoperative analgesic efficacy and safety compared to the suprainguinal fascia iliaca (SFI) block in patients undergoing primary hip arthroplasty using the same injectate volume. **Material and Methods.** Between January 2021 and March 2022, American Society of Anesthesiologists Physical Status (ASA-PS) classification I–III patients scheduled for hip arthroplasty were included in this study. After standard monitoring and subarachnoid anesthesia, an ultrasound-guided PENG or SFI block with 20 ml of 0.25% levobupivacaine was performed for postoperative analgesia. All patients were assessed with a numerical rating scale (NRS) at presurgery, upon arrival at the postanesthesia care unit (PACU), and in the postoperative period at 2, 4, 12, and 24 hours. The need for analgesic rescue and adverse effects was also assessed. **Results.** A total of 130 patients were included in the study (62 PENG block and 68 SFI block). Both blocks were equally effective in managing postoperative pain without any statistically significant differences except at 12 h ($p = 0.023$), where the deviation found was not clinically relevant. The median total morphine consumption was 0 mg [0–2] in the PENG block group and 0 mg [0–2] in the SFI block group. A more significant motor block was found in the first 6 hours in the SFI block group ($p = 0.001$). There was no significant difference in the ease of performing PENG (79%) or SFI (85%) blocks. No major

complications were recorded in both groups, and patient satisfaction was high (83.9% for the PENG block group vs. 91.2% for the SFI block group). *Discussion.* Both blocks have been demonstrated to be effective for postoperative analgesia in hip arthroplasty and should be integrated as a multimodal analgesic strategy. The lesser degree of motor block recorded in the first hours with the PENG block makes it the most suitable option for early recovery. Both techniques were easy and safe to perform.

1. Introduction

Osteoarthritis of the hip is a noninflammatory disease of slow and irreversible progression, characterized by the gradual destruction of articular cartilage. Conservative treatment should be the first option, but if moderate-intense pain and functional disability persist, hip arthroplasty should be considered. The NICE guideline recommends taking into consideration performing a nerve block in two situations: when paracetamol and nonsteroidal anti-inflammatory drugs (NSAIDs) do not provide sufficient analgesia or to limit the administration of opioids [1]. The PROSPECT guidelines include, among their suggestions, the fascia iliaca block [2]. These recommendations suggest that nerve blocks form part of the multimodal strategy. It remains to be defined which block best facilitates recovery and does not delay mobilization in primary hip arthroplasty.

The innervation of the hip region is anatomically intricate. It involves branches from both the lumbar region, such as the femoral nerve, obturator nerve, accessory obturator nerve, lateral femoral cutaneous nerve, as well as the sacral plexuses, primarily the superior and inferior gluteal nerves. Additionally, the hip receives innervation from the quadratus femoris branch of the sacral plexus and, to a lesser extent, some direct branches of the sciatic nerve.

In a histological study conducted by Gerhardt et al. [3], it is found that the anterior and superolateral portions of the joint capsule predominantly contain nociceptive fibers, whereas the posterior and inferior sections primarily exhibit neural fibers identified as mechanoreceptors. Based on this study, the target nerves would be the femoral, obturator, and accessory obturator nerves. This premise was recently confirmed by Short et al. [4] in their anatomical study, in which they also concluded that both the femoral nerve and the accessory obturator nerve play a greater role in the innervation of the hip capsule than previously reported. Between the anterior inferior iliac spine and the iliopubic eminence, the high articular branches of the femoral nerve and the accessory obturator nerve can consistently be found, while closer to the inferomedial acetabulum, the articular branches of the obturator nerve are situated.

This information led the Girón-Arango group to recently develop an ultrasound-guided technique to block these articular nerves by the pericapsular nerve group (PENG) block [5]. However, most studies of postoperative analgesia after hip arthroplasty are carried out with the suprainguinal fascia iliaca (SFI) block. A recent meta-analysis published by Zhang et al. [6] showed that SFI block is associated with a decrease in pain in the first 24 hours, less need for opioids, and a lower incidence of nausea. PENG block and SFI block

for hip analgesia have been reported previously, but neither used the same regimen, making the comparison and conclusion difficult.

The aim of the present study was to compare the effectiveness and safety of PENG block with suprainguinal fascia iliaca block in patients undergoing primary hip arthroplasty using the same injectate volume.

2. Materials and Methods

A prospective, nonrandomized, multicenter observational study was designed in two tertiary hospitals, in which two analgesic strategies included within the usual anesthetic practice were compared to monitor postoperative pain after primary hip arthroplasty surgery. After approval of the study by the Galician Research Ethics Committee (registry 2020/253) and after obtaining informed consent, we consecutively selected 130 patients who met the inclusion criteria: being over 18 years of age, physical status ASA I–III scheduled for primary hip arthroplasty surgery.

The exclusion criteria were the following: any contraindication for performing regional techniques (infection at the puncture point, alteration of haemostasis, and allergy to local anesthetics), refusal of the patient to participate in the study, nonapproval of informed consent, inability to assess postoperative pain, cognitive impairment, poorly controlled diabetes mellitus, known neuropathy of the operated limb, and patients who required conversion to general anesthesia.

In the operating room, all the selected patients were monitored with a three-lead electrocardiogram, noninvasive blood pressure, and peripheral oxygen saturation. Intravenous omeprazol 40 mg and antibiotic prophylaxis with 2 g of cefazolin were administered. All patients received spinal anesthesia with isobaric bupivacaine 0.5% 10 mg + fentanyl 10 mcg to achieve a level of T10–T12 anesthetic block. Preoperatively, peripheral blocks were performed, both guided by ultrasound with 20 ml of 0.25% levobupivacaine determined by the two study groups.

The PENG blocks were performed at the Álvaro Cunqueiro University Hospital Complex, while the SFI blocks were performed at the Central University Hospital of Asturias. Prior to surgery, all of them were performed under ultrasound guidance by two anesthesiologists with extensive experience in regional ultrasound techniques. An M-Turbo portable ultrasound machine (Sonosite®, Bothell, WA, USA) with a linear (7–12 MHz) or curved (1–5 MHz) transducer was used, depending on the depth of the blockage and a Pajunk® 22G 80–100 mm sonoplex needle, depending on the target depth.

2.1. PENG Block Group. With the patient in the supine position, a convex probe was placed at the level of the anterior inferior iliac spine and aligned with the pubic ramus, rotating the probe 45° clockwise/counterclockwise depending on whether we were on the right/left side in the direction to the head of the femur. With this transverse view, we can easily identify the iliopubic eminence, the psoas muscle and its tendon, the femoral artery, and the pectineus muscle. An 80 mm 22G needle was inserted from lateral to medial, placing the tip on the musculofascial plane delimited anteriorly by the psoas tendon and posteriorly by the pubic ramus. After negative aspiration through the needle, 2 ml of local anesthetic was given to confirm the correct opening of the fascial plane, followed by 0.25% levobupivacaine administration with a volume up to a total of 20 mL.

2.2. SFI Block Group. With the patient in the supine position, the longitudinal ultrasound linear probe was placed at the level of the anterior superior iliac spine, following the fascia iliaca along the inguinal ligament medially until the “bowtie sign” appeared, formed by three muscles that, from caudal to cranial, comprised the sartorius muscle, the iliacus muscle, and the internal oblique muscle. An 80 mm 22G needle was inserted from caudal to cranial with an in-plane approach. A hydrodissection was then performed under the fascia iliaca with 20 ml of 0.25% levobupivacaine after confirming negative aspiration and correct opening of the fascial plane with a cephalic extension of the anesthetic, taking care not to puncture the deep circumflex iliac artery.

2.3. Evaluation of the Results. After the intervention, the patients were transferred to the postanesthetic care unit (PACU). Prior to the intervention, all patients were trained in pain assessment using a numerical rating scale (NRS) from 0 (no pain) to 10 (maximum pain endured). All received the same regimen of postoperative intravenous analgesia, the combination of 50 mg of dexketoprofen and 1 g of paracetamol every 8 hours, and, as rescue if NRS >3, intravenous morphine was administered at a dose of 0.04 mg/kg every 10 minutes until NRS <3. The nursing staff and the anesthesiologist in charge of the PACU were blind to the block the patient received in each study group.

The primary endpoint was pain intensity according to the NRS value before surgery, upon arrival of the patient at the PACU, and in the postoperative period at 2, 4, 12, and 24 hours. As secondary endpoints, we measured additional analgesic requirements (in mg of morphic chloride) in the first 24 postoperative hours, the rate of adverse effects (postoperative nausea and vomiting and urinary retention), motor block assessed by leg movement using the modified Bromage scale (0 = can raise the extended leg, 1 = unable to flex knee, 2 = unable to flex ankle, and 3 = complete motor block), ease of the performance of the technique by the anesthesiologist using a simple verbal scale (easy, medium difficulty, and difficult), and the degree of patient satisfaction (very satisfied, satisfied, and dissatisfied) at 24 hours postoperatively.

2.4. Statistical Analysis. To achieve 80% of statistical power to detect differences using a two-tailed Student's *t*-test between two independent samples, taking into account a significance level of 5.00%, and assuming a mean NRS value of 2.0 units at 2 hours in the SFI block group, a mean of 1.5 units in the PENG block group, and a joint standard deviation of 1.0, it will be necessary to include 64 patients per group, totaling 128 patients in the study.

A descriptive analysis of all the variables collected was carried out, indicating frequency and percentage for the categorical variables and means, standard deviations, and ranges for the normal quantitative ones, or median and interquartile range if it did not follow normality. For the study of normality, the Kolmogorov–Smirnov statistic was used.

The comparisons of both effectiveness and safety between the two groups were analyzed using the chi-square test for categorical variables and Student's *t*-test for numerical variables, while for intragroup comparisons we used McNemar's test for qualitative variables and the Student's *t*-test for samples related to quantitative variables. If the data of the quantitative variables do not follow a normal distribution, the equivalent nonparametric Mann–Whitney's *U* tests for independent groups and the Wilcoxon test for related samples were used. The variation in pain throughout the follow-up was analyzed using ANOVA or the Kruskal–Wallis test, depending on whether the distribution of the variable was normal or not. To compare the final adverse effects according to the different treatments, they were analyzed using chi-square test. Significance was set at $P < 0.05$. The Bonferroni correction was used to adjust for multiple comparisons.

The statistical analysis was carried out with the IBM SPSS Statistics for Mac version 26 program.

3. Results

One hundred forty-one patients were included in the study: 67 in the PENG block group and 74 in the SFI block group. Eight patients were excluded (Figure 1), and three patients were lost in the data analysis during follow-up (one patient from SFI block group and two from the PENG block group).

Of the 130 patients finally included in the statistical analysis (62 for the PENG block group and 68 for the SFI block group), there were no statistical differences between the two groups regarding demographic characteristics and surgical laterality, except for the variables sex and ASA I-II (Table 1).

3.1. Postoperative Pain and Morphine Consumption. Figure 2 and table 2 show the data regarding the pain assessment before and after surgery in the indicated study periods measured by the NRS scale. As observed in the data, registered pain values are under 5/10, corresponding to mild pain, moderate (6-7/10), or severe (>8/10).

In the course of the study period, no statistically significant differences were found between the two blocks, except at 12 hours ($p = 0.023$), this difference not being clinically significant (2 [2-3] for the PENG block group and 2 [2-4] for the SFI block group).

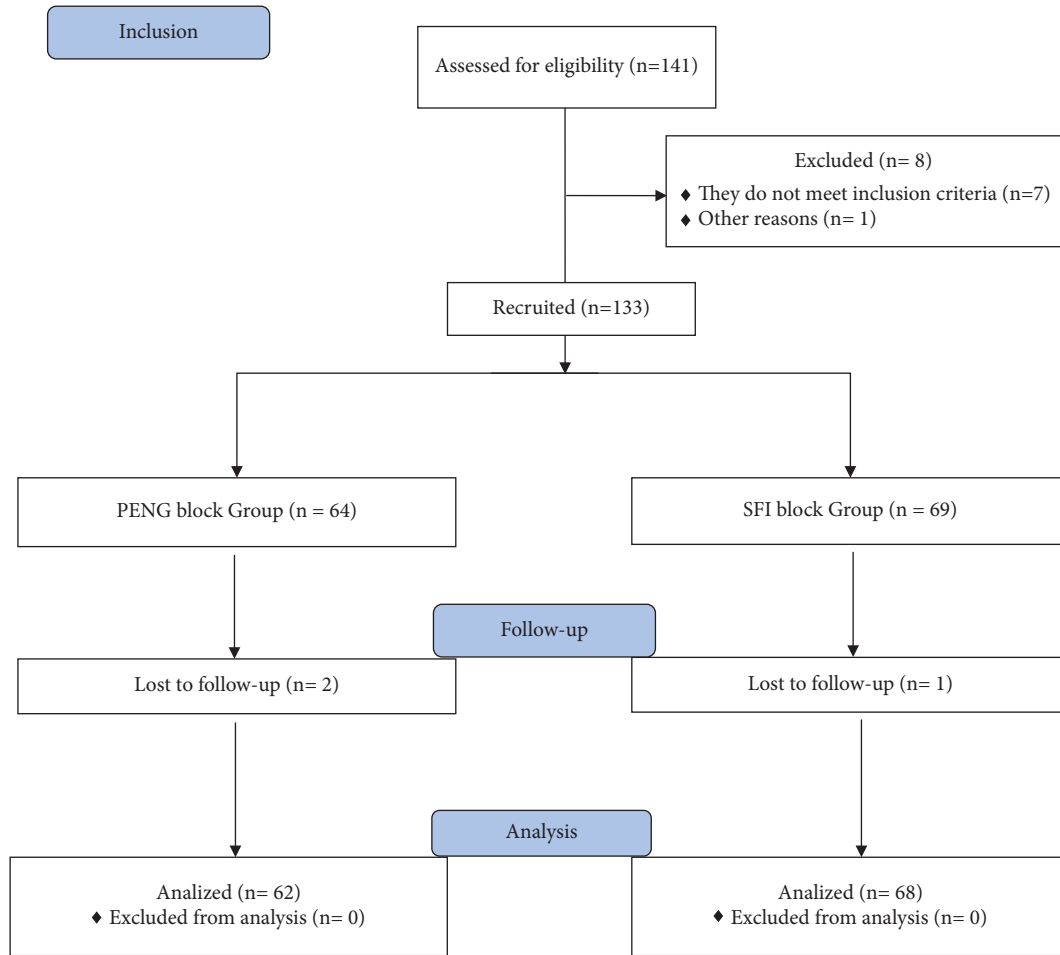


FIGURE 1: Flowchart of the study.

TABLE 1: Demographic data.

Variables	PENG block (n = 62)	SFI block (n = 68)	P value	
Males	42 (67.7%)	30 (44.1%)	0.008*	
Age	69.02 [14.71]	73.26 [3.99]	0.27	
BMI	28.2 [3.99]	29.36 [3.87]	0.2	
ASAPS	I	6 (9.7%)	0 (0%)	0.01*
	II	18 (29%)	35 (51.5%)	0.012*
	III	38 (61.3%)	33 (48.5%)	0.16
	IV	0 (0%)	0 (0%)	—
Left side	26 (41.9%)	33 (48.5%)	0.48	

Data are expressed as absolute value and percentage or mean and standard deviation as appropriate. BMI: body mass index. ASAPS: American Society Anesthesiologists Physical Status. Statistically significant differences are marked with *.

The median total consumption of morphine was 0 mg [0–2] in the PENG block group and 0 mg [0–2] in the SFI block group. Neither the amount of morphine consumption nor the number of rescue analgesics reached a statistically significant difference between the two groups.

3.2. Postoperative Motor Block. The degree of motor block was studied at 6 and 12 hours of the postoperative period using the modified Bromage scale (Figure 3). At 6 hours, 56

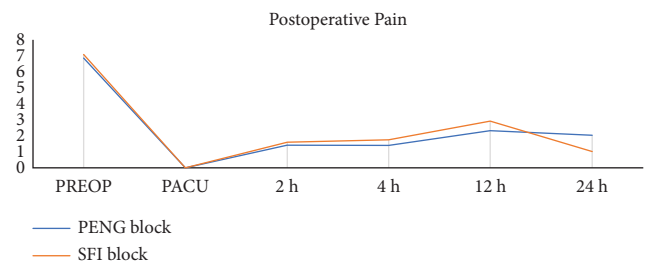


FIGURE 2: Pre- and postoperative assessment in the different measurement periods. Preop: preoperative. PACU: postanesthetic care unit.

patients (90%) presented a Bromage 0 in the PENG block group, while only 7 (10%) of them did in the SIF block group, this difference being statistically significant ($p < 0.01$). At 12 hours, no significant differences were found between both groups.

As per the usual protocol of the traumatology service, all patients sat in the chair the afternoon after surgery and they began ambulation 24 hours after surgery.

3.3. Block Execution Difficulty and Side Effects. Regarding the ease of performing the blocks (Table 3), 79% of the PENG blocks and 85% of the SFI blocks were considered easy, with

TABLE 2: Pre- and postoperative assessment in the different measurement periods.

Variables	PENG block (<i>n</i> = 62)	SFI block (<i>n</i> = 68)	<i>P</i> value
NRS Preop	7 [6–8]	7 [6–8]	0.95
NRS 2H	2 [0–2]	2 [0–3]	0.47
NRS 4H	2 [0–2]	2 [1–3]	0.19
NRS 12H	2 [2–3]	2 [2–4]	0.02
NRS 24H	2 [1–3]	2 [2–2]	0.68
Morphine consumption	0 [0–2]	0 [0–2]	0.81

Data are expressed in median and range. NRS: numerical rating scale. Preop: preoperative.

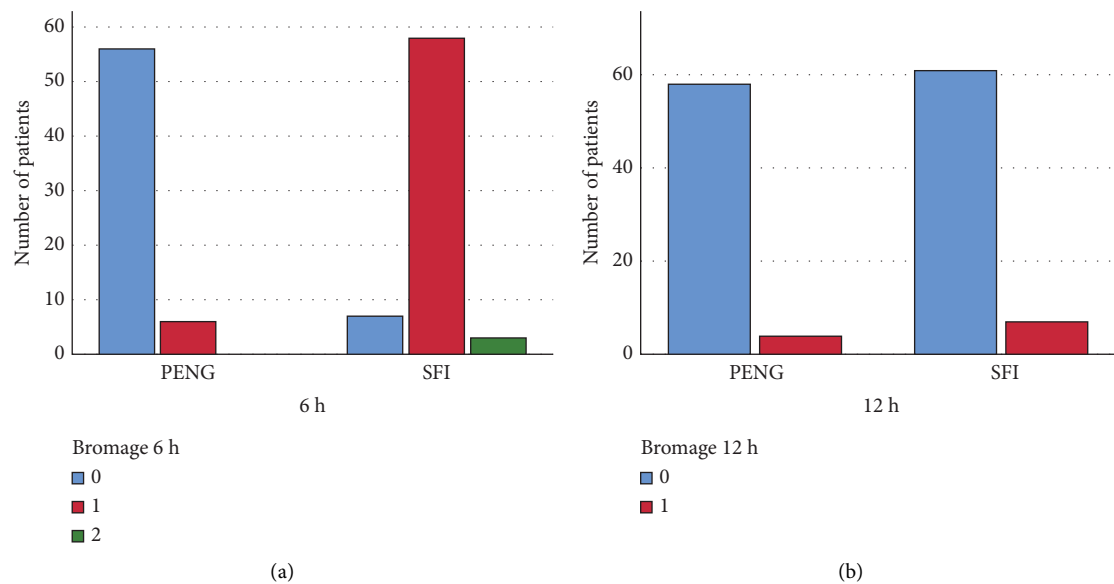


FIGURE 3: Bromage scale according to the type of block performed. (a) Bromage measured at 6 hours. (b) Bromage measured at 12 hours.

TABLE 3: Statistical results according to the study variables.

Variables	PENG block (<i>n</i> = 62)	SFI block (<i>n</i> = 68)	<i>P</i> value	
PONV	6 (9.6%)	5 (7.4%)	0.75	
Itchiness	0 (0%)	2 (2.9%)	0.49	
Sedation	2 [2–2]	2 [2–2]	0.2	
Urine retention	5 (8%)	6 (8.8%)	0.8	
Rest	Good	44 (71%)	34 (50%)	0.01
	Regular	18 (29%)	34 (50%)	0.01
	Bad	0 (0%)	0 (0%)	—
Ease of performing the block	Easy	49 (79%)	58 (85.3%)	0.36
	Intermediate	13 (21%)	10 (14.7%)	0.36
	Hard	0 (0%)	0 (0%)	—
Satisfaction	Unsatisfied	3 (4.8%)	0 (0%)	0.10
	Satisfied	52 (83.9%)	62 (91.2%)	0.28
	Very satisfied	7 (11.3%)	6 (8.8%)	0.77

PONV: postoperative nausea and vomiting.

no difference between them. In both groups, 2 cases of surgical wound hematoma were found. Table 3 also shows the data related to PONV, itchiness, sedation, and urine retention. We did not find differences between groups.

Almost all the patients were satisfied with the analgesia received (83.9% for the PENG block group vs. 91.2% for the SFI block group), and there were only three patients (4.8%) who were dissatisfied in the PENG block group.

4. Discussion

To the best of our knowledge, our study is the first one comparing PENG and SFI blocks using the same injectate volume in hip arthroplasty. We have not found significant differences in the postoperative pain score nor in the total cumulative morphine dose in 130 patients undergoing primary hip arthroplasty on whom PENG and SFI blocks were used as an analgesic strategy. We have also observed a lesser degree of motor block in the PENG group in the first postoperative hours since only the purely sensory articular branches are targeted. These same conclusions have previously appeared in clinical trials, where the PENG block, compared to SFI block, offers a useful alternative with few complications, the same pain control, the same consumption of postoperative opioids, less motor block [7], and better analgesic control for positioning [8] but with different volume of local anesthetic between groups.

It is still unclear which is the best analgesic strategy in patients undergoing primary hip arthroplasty surgery, especially in the elderly [9]. In this sense, classically, the use of opioids was one of the fundamental pillars in terms of intra- and post-operative analgesic control, but at the expense of side effects that delayed postoperative recovery. There is a commitment to multimodal analgesia regimens [10] in which different drugs and regional techniques are combined to act at different points in the pain generation and perception circuits. In a Cochrane [11] review, it is mentioned that regional anesthesia techniques offer superior pain control in comparison to conventional analgesia. Additionally, they have the potential to be associated with a reduced risk of delirium and postoperative confusion, increased patient satisfaction, and shorter hospital stays.

PENG block is a very recent alternative to femoral nerve block. Lin et al. [12] found better analgesic control with respect to the femoral nerve block in patients undergoing surgery for hip fracture. It could constitute a better regional technique to control pain and prevent quadriceps weakness after hip surgery. Pires Sousa et al. [13] find it equivalent to epidural analgesia in terms of the quality of postoperative analgesia for patients undergoing primary hip arthroplasty with fewer complications.

Although the analgesic effect of PENG block and SFI block is remarkable and replicable in different centers, comparisons between different studies are difficult because they use different volumes of local anesthetic. The ideal dose and volume to perform these two blocks are still under discussion. In the case of PENG block, there is only one dispersion study in corpses with methylene blue carried out by Tran et al. [14], concluding that around 20 ml would be sufficient for articular nerve targets. However, more evidence is still needed as to where the local anesthetic is distributed precisely. Regarding SFI block, the latest publication is in favor of using a dose of around 30–40 ml for SFI block in order to obtain a greater cephalic diffusion of the local anesthetic towards the suprainguinal branches of the three nerves, i.e., femoral nerve, lateral femoral cutaneous nerve, and obturator nerve [15].

In our study, we have used the same dose of local anesthetic in both groups (20 ml in each group), unlike the work of Aliste et al. [7] (20 ml for PENG block and 40 ml for SFI block), reaching the same conclusions in terms of the analgesic quality. However, the use of double volume could act as a confounding factor regarding the expected postoperative motor block. We have found that at 6 hours after surgery, 90% of the patients in the PENG block group presented a Bromage 0, while in the SFI block group, there was only 10% of patients scored 0 on the Bromage scale, indicating that most of the latter presented a higher degree of weakness of the quadriceps muscle.

There is an anatomical plausibility that may explain this difference. In the first place, with the PENG block, we impregnate the purely sensory articular branches of the femoral, obturator, and accessory obturator nerve with local anesthetic. In contrast, with the SFI block, there is a greater cephalic diffusion of the local anesthetic towards the terminal branches (not only joints) of the lumbar plexus (femoral, lateral femoral cutaneous, and obturator). Despite this, the PENG block is not exempt from being able to produce motor block fundamentally related to the volume and site of the injection. Thus, it has been seen in different published studies that if the injection is made in the thickness of the psoas muscle, it could spread superficially until it reaches the femoral nerve. If a high volume of local anesthetic is used, it can spread through the fascial plane between the psoas muscle and the pectineus toward the femoral neurovascular bundle, producing quadriceps weakness [16].

Although peripheral nerve blocks are part of the daily work of anesthesiologists, to perform them safely and successfully it is necessary to combine a good anatomical knowledge of the area to be blocked and good training in ultrasound-guided puncture techniques. As mentioned in the review by Reza et al. [17], gender largely conditions the pelvic anatomy so that men generally have a deeper injection area, which could be an added difficulty. In our study, despite differences in the sex variable (67.7% of men), we found no association between the sex variable and the difficulty in performing PENG block.

In both groups, two hematomas from the surgical wound were recorded, without being able to directly link them to the block performed. In our work, postoperative infections were not recorded, although it has been reported that the infection rate after performing single ultrasound-guided blocks is very low [18]. It is logical that the risk could be more significant after PENG block since the puncture site overlaps the surgical field, although more studies would be necessary to confirm this hypothesis.

The main strengths of our study were threefold. Firstly, it would be the prospective and multicenter nature of this study. Secondly, all the blocks were performed by two anesthesiologists with extensive experience in echo-guided regional anesthesia within their usual clinical practice to avoid bias. Thirdly, the same dose of local anesthetic was administered in both groups and both were easy to perform. Therefore, these two blocks can be an alternative used by the vast majority of anesthesiologists within multimodal analgesia in hip surgery.

Our work has several limitations and possible biases. The main one resides in the observational design without randomization, which yields scientific evidence that is not as high as in a clinical trial. Another limitation is that it is a multicenter study, but it has only been carried out in two hospital centers. Also, there may be a selection bias because it has been carried out in tertiary-level hospitals where patients with less comorbidities may not be operated. And finally, there is difficulty in comparing results with other studies due to great variability of dose and volume of local anesthetic used.

Regardless of the limitations, our results are similar to other studies showing that fascial and capsular blocks in hip arthroplasty provide good analgesia within the multimodal strategy for hip surgery [12, 14, 15, 19]. Nevertheless, we still need more randomized studies to be able to assert that postoperative analgesia requirements are different and that the choice of one or the other block has repercussions in clinical practice.

In conclusion, PENG and SFI blocks are analgesic supplements that could be considered first-line in multimodal analgesia for postoperative pain control after primary hip arthroplasty, since they are useful, safe, and easy-to-perform techniques. One difference to consider between them is that with PENG, a lesser degree of motor block is obtained in the first postoperative hours since only the purely sensory articular branches are intended to be blocked, which may be a defining feature in hospitals where patients are on clinical pathways for intensified recovery from trauma surgery [20].

Data Availability

Data are available upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

I-Chi Wu and Jui-An Lin are equally contributed.

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