



Original Article

## Ultrasound-Guided Pericapsular Nerve Group (PENG) Block as an Analgesic Modality in Hemi Arthroplasty Under Regional Anesthesia

Dr Gazanfar Rafiq<sup>1</sup>, Dr Afeefah Jamsheed<sup>2</sup>, Dr. Syeeda Manahil Hussanie<sup>3</sup>, Dr Rukhsana Najeeb<sup>4</sup>

<sup>1</sup>Postgraduate Scholar, Department of Anaesthesiology & Critical care medicine, Government Medical College, Srinagar, India.

<sup>2</sup>Senior Resident, Department of Anaesthesiology, SKIMS, Soura, Srinagar, India.

<sup>3</sup>Senior Resident, Department of Anaesthesiology & Critical care medicine, Government Medical College, Srinagar, India.

<sup>4</sup>Professor and Dean, Government Medical College Anantnag, Jammu and Kashmir, India.

OPEN ACCESS

### ABSTRACT

#### Corresponding Author:

**Dr. Syeeda Manahil Hussanie**

Senior Resident, Department of Anaesthesiology & Critical care medicine, Government Medical College, Srinagar, India.

Received: 20-04-2026

Accepted: 13-05-2026

Available online: 23-05-2026

**Background:** Effective postoperative pain control after hip arthroplasty is essential for early mobilization and recovery. The ultrasound-guided Pericapsular Nerve Group (PENG) block has emerged as a novel motor-sparing technique aimed at improving analgesia following hip surgery. This study evaluated the effectiveness of the PENG block in reducing postoperative pain and analgesic consumption in patients undergoing hip arthroplasty under regional anaesthesia. **Methods:** This prospective observational study was conducted at a tertiary care center and included 60 patients undergoing hip arthroplasty under spinal anaesthesia. Patients were divided into two groups: Group A (n = 30) received ultrasound-guided PENG block in addition to spinal anaesthesia, while Group B (n = 30) received spinal anaesthesia with conventional postoperative analgesia. Postoperative pain was assessed using the Visual Analogue Scale (VAS) at 2, 4, 6, 8, 12, 24, and 48 hours. Duration of analgesia, total analgesic consumption over 24 hours, and incidence of adverse effects were recorded and compared between groups. **Results:** Baseline demographic variables, ASA physical status, and level of spinal block were comparable between the groups. VAS scores were significantly lower in Group A from 4 to 12 hours postoperatively ( $p < 0.0001$ ). At 6 hours, mean VAS scores were  $0.9 \pm 1.16$  in Group A versus  $3.7 \pm 2.14$  in Group B. The mean duration of postoperative analgesia was significantly longer in Group A ( $7.13 \pm 1.01$  hours) compared to Group B ( $5.13 \pm 1.01$  hours,  $p < 0.0001$ ). Total 24-hour analgesic consumption was significantly lower in Group A ( $109.17 \pm 34.42$  mg) than in Group B ( $243.33 \pm 58.33$  mg,  $p < 0.0001$ ). Postoperative nausea and vomiting were more frequent in Group B, with a statistically significant difference between groups ( $\chi^2 \approx 9.97$ ,  $p < 0.01$ ). Pain scores at 24 and 48 hours were comparable between the two groups. **Conclusion:** Ultrasound-guided PENG block provides superior early and mid-postoperative analgesia, prolongs the duration of analgesia, reduces postoperative analgesic requirements, and is associated with fewer adverse effects compared to conventional analgesia following hip arthroplasty under regional anaesthesia.

Copyright © International Journal of Medical and Pharmaceutical Research

**Keywords:** Pericapsular nerve group block, PENG block, Hemi arthroplasty, Postoperative analgesia, Regional anaesthesia, Visual analogue scale.

### INTRODUCTION

Hip arthroplasty is a widely performed orthopedic procedure for conditions such as fractures of the neck of femur, osteoarthritis, and avascular necrosis of the femoral head. Despite advances in surgical techniques and perioperative care, patients undergoing hip arthroplasty frequently experience moderate to severe postoperative pain, which can adversely affect early mobilization, rehabilitation, and overall recovery (1,2). Inadequate pain control has been associated with increased morbidity, prolonged hospital stay, delayed ambulation, and reduced patient satisfaction (3).

Spinal anaesthesia is commonly employed for hip arthroplasty owing to its reliability, rapid onset, and favorable safety profile, particularly in elderly patients (4). However, the analgesic effect of spinal anaesthesia is time-limited, and significant postoperative pain often develops following regression of the block, necessitating the use of systemic analgesics (5). Opioids and non-steroidal anti-inflammatory drugs (NSAIDs), although effective, are frequently associated with adverse effects such as nausea, vomiting, sedation, respiratory depression, renal dysfunction, and gastrointestinal complications (6,7). These concerns have driven the increasing adoption of multimodal analgesic strategies incorporating regional nerve blocks.

Various regional anaesthetic techniques have been described for postoperative analgesia following hip surgery, including femoral nerve block, fascia iliaca compartment block, and lumbar plexus block (8,9). While these techniques provide effective analgesia, they are often associated with varying degrees of motor blockade, particularly quadriceps weakness, which may delay early mobilization and increase the risk of falls (10,11). Preservation of motor function is especially important in elderly patients undergoing hip arthroplasty, where early physiotherapy and ambulation are critical components of postoperative recovery (12).

The hip joint receives complex innervation from the femoral, obturator, accessory obturator, and sciatic nerves, with the anterior capsule being the principal source of nociceptive input (13). Traditional nerve blocks may not consistently target the articular branches supplying the hip capsule, leading to variable analgesic efficacy (14). In this context, the ultrasound-guided Pericapsular Nerve Group (PENG) block has emerged as a novel regional anaesthetic technique specifically designed to provide analgesia to the anterior hip capsule by selectively blocking the articular branches of the femoral nerve, obturator nerve, and accessory obturator nerve (15).

Since its description, the PENG block has gained attention as a potentially motor-sparing block capable of providing effective postoperative analgesia without significant quadriceps weakness (16). Early studies and clinical reports have suggested that the PENG block may result in improved pain scores, prolonged duration of analgesia, and reduced opioid consumption following hip surgeries (17,18). However, evidence regarding its effectiveness remains limited, particularly in prospective clinical settings comparing PENG block with conventional postoperative analgesic strategies under spinal anaesthesia (19).

Given the need for effective, motor-sparing analgesic techniques in patients undergoing hip arthroplasty, further evaluation of the PENG block is warranted. The present prospective observational study was therefore undertaken to assess the effectiveness of ultrasound-guided PENG block as an adjunct to spinal anaesthesia for postoperative analgesia in patients undergoing hip arthroplasty. The study aimed to compare postoperative pain scores, duration of analgesia, analgesic consumption, and incidence of adverse effects between patients receiving PENG block and those managed with conventional postoperative analgesia.

## MATERIALS AND METHODS

### Study Design and Setting

This prospective observational study was conducted at the **Bone and Joint Hospital**, an associated tertiary care hospital of **Government Medical College (GMC), Srinagar**, over a period of **18 months**. The study was carried out in the operating theatres and postoperative recovery areas of the hospital.

### Study Population

A total of **60 adult patients** scheduled to undergo hip arthroplasty under regional anaesthesia were included in the study. Patients were allocated into two groups based on the postoperative analgesic technique employed:

- **Group A (PENG group; n = 30):** Patients received ultrasound-guided Pericapsular Nerve Group (PENG) block in addition to spinal anaesthesia.
- **Group B (Control group; n = 30):** Patients received spinal anaesthesia followed by conventional postoperative analgesia.

This was a **non-randomized observational study**, and group allocation was determined by the preference of the attending anaesthesia consultant.

### Inclusion Criteria

- Patients aged **18–70 years**
- Either sex
- American Society of Anesthesiologists (ASA) physical status **I or II**
- Patients scheduled for elective hip arthroplasty under regional anaesthesia
- Patients who provided written informed consent

### Exclusion Criteria

- Patient refusal

- ASA physical status **III or higher**
- Pre-existing chronic pain disorders
- Coagulopathy or bleeding disorders
- Known allergy to local anaesthetic agents
- Local infection at the injection or surgical site
- Pre-existing neuropraxia or significant neurological deficits in the hip region

### Anaesthetic Technique

All patients received **subarachnoid block (spinal anaesthesia)** using **0.5% hyperbaric bupivacaine (3 mL)** administered under standard aseptic precautions. The level of spinal block achieved was documented intraoperatively. In **Group A**, following spinal anaesthesia, an ultrasound-guided PENG block was performed using **20 mL of 0.2% ropivacaine** under real-time ultrasound guidance.

In **Group B**, patients received spinal anaesthesia followed by conventional postoperative analgesia as per institutional protocol.

### Intraoperative Monitoring

Intraoperative monitoring included continuous assessment of:

- Heart rate
- Non-invasive blood pressure
- Oxygen saturation (SpO<sub>2</sub>)

Hemodynamic parameters were recorded at **5, 10, 15, 30, 45, and 60 minutes** intraoperatively. Patients were monitored for any intraoperative adverse events such as hypotension, bradycardia, or signs of local anaesthetic systemic toxicity.

### Postoperative Pain Assessment

Postoperative pain was assessed using the **Visual Analogue Scale (VAS)**. Pain scores were recorded at **2, 4, 6, 8, 12, 24, and 48 hours** following surgery.

### Postoperative Analgesia Protocol

- **First rescue analgesia:** Intravenous paracetamol was administered when VAS score  $\geq 3$ .
- **Second rescue analgesia:** If pain persisted, intravenous tramadol or diclofenac was administered as per standard hospital practice.

### Outcome Measures

The primary outcome measures were:

- Postoperative VAS pain scores at predefined time intervals
- Duration of postoperative analgesia (time from spinal anaesthesia to first rescue analgesic requirement)

Secondary outcome measures included:

- Total analgesic consumption within the first 24 hours
- Incidence of postoperative adverse effects such as nausea, vomiting, hypotension, bradycardia, local anaesthetic toxicity, or neurological complications

### Follow-Up and Safety Assessment

Patients were monitored throughout their hospital stay for any immediate or delayed complications related to the PENG block. Follow-up assessments were conducted up to **48 hours postoperatively** to document pain scores and adverse effects.

### Statistical Analysis

Data were analyzed using **SPSS software**. Continuous variables were expressed as mean  $\pm$  standard deviation, while categorical variables were expressed as frequencies and percentages. Intergroup comparisons of continuous variables were performed using the **independent t-test** or **Mann–Whitney U test**, as appropriate. Categorical variables were analyzed using the **chi-square test** or **Fisher's exact test**. A p-value of  $< 0.05$  was considered statistically significant.

### Ethical Considerations

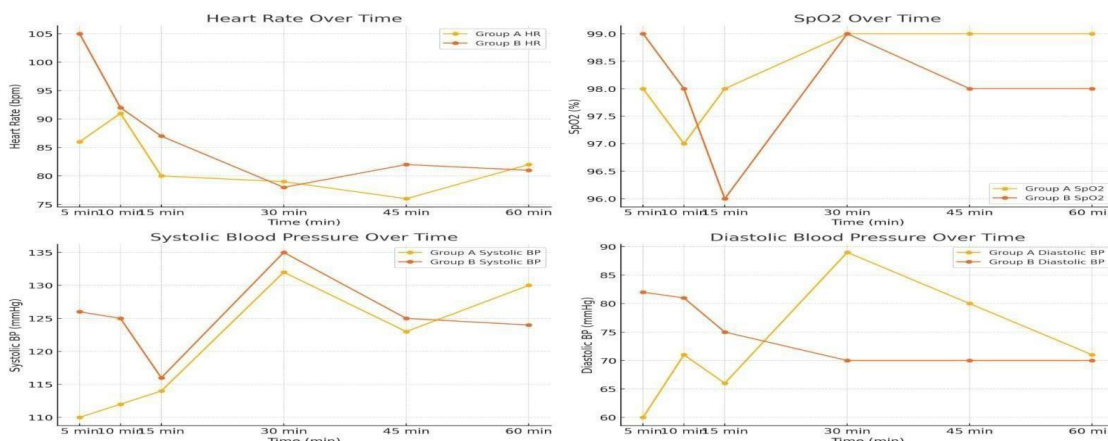
The study was approved by the **Institutional Ethics Committee of Government Medical College, Srinagar**. Written informed consent was obtained from all participants prior to enrolment, and the study was conducted in accordance with the **Declaration of Helsinki**.

**RESULTS**

The demographic and baseline clinical characteristics were comparable between the two study groups. There were no statistically significant differences with respect to age distribution, gender, or ASA physical status [Table 1].

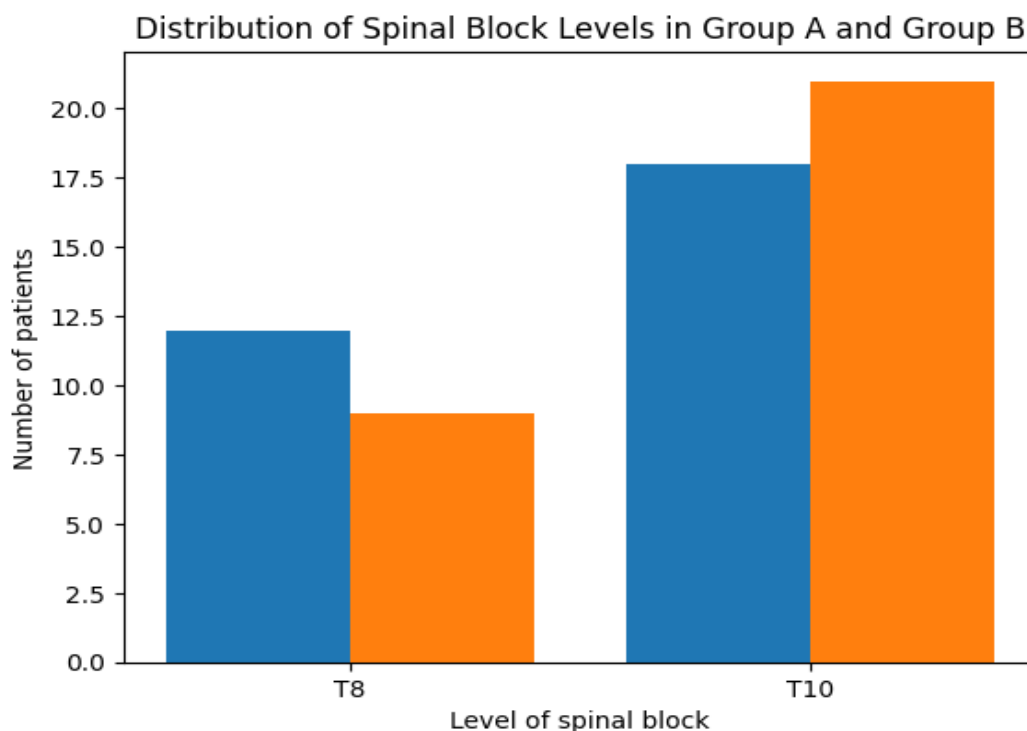
**Table 1: Demographic and baseline characteristics of study participants**

Parameter	Category	Group A (n = 30)	Group B (n = 30)	Total (n = 60)	p-value
Gender	Male	15	18	33	0.436
	Female	15	12	27	
Age (years)	< 60	11	18	29	0.07
	≥ 60	19	12	31	
ASA physical status	ASA I	6	9	15	0.31
	ASA II	24	21	45	



**Figure 1. Intraoperative hemodynamic trends in Group A and Group B**

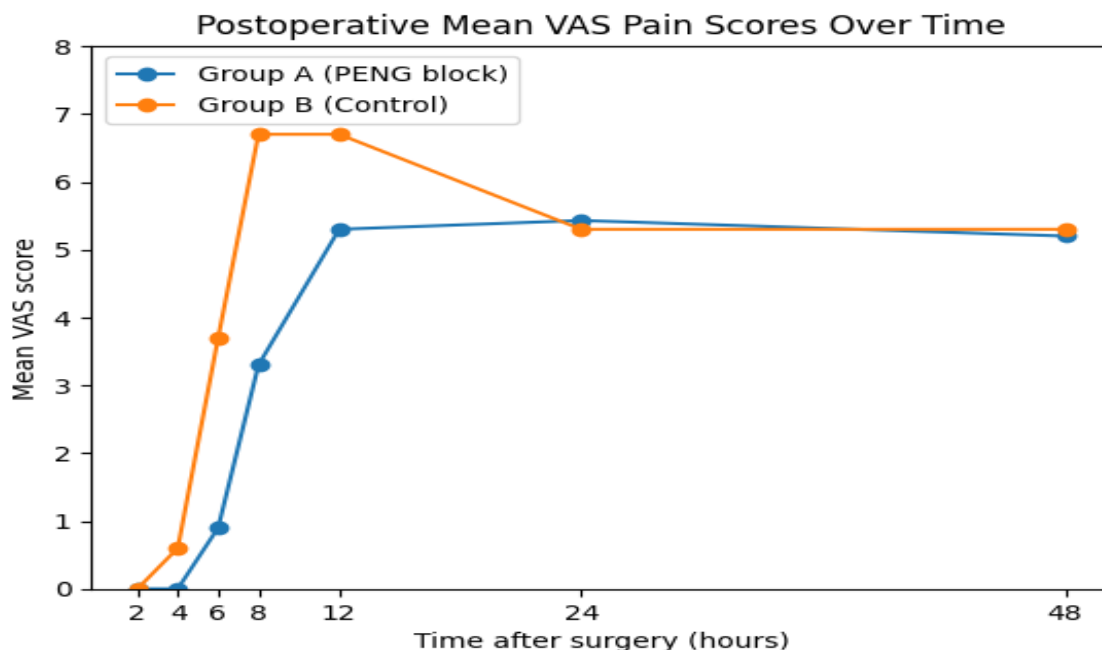
Both groups demonstrated stable intraoperative hemodynamics throughout the observation period. Heart rate, blood pressure, and oxygen saturation values followed comparable trends in Group A and Group B, with no clinically or statistically significant differences at any time



**Figure 2.** Bar chart showing the distribution of spinal block levels achieved in Group A and Group B. T10 was the most commonly achieved level in both groups, with no statistically significant difference in block height distribution between the two groups.

### Postoperative Pain Scores (VAS)

Postoperative pain was assessed using the Visual Analogue Scale (VAS) at 2, 4, 6, 8, 12, 24, and 48 hours.



**Figure 3.** Comparison of postoperative VAS pain scores between Group A and Group B at different time intervals

VAS scores were comparable at 2 hours in both groups. Group A demonstrated significantly lower pain scores from 4 to 12 hours postoperatively. At 24 and 48 hours, pain scores converged with no statistically significant difference between groups.

The duration of analgesia was defined as the time from spinal anesthesia to the requirement of first rescue analgesia [Table 2].

**Table 2: Comparison of duration of postoperative analgesia**

Group	N	Mean duration (hours)	SD	Minimum	Maximum	p-value
Group A	30	7.13	1.01	6	8	<0.0001
Group B	30	5.13	1.01	4	6	

Group A had a significantly longer duration of postoperative analgesia compared to Group B.

**Table 3. Comparison of paracetamol consumption in the first 24 hours**

Group	N	Mean dose (mg)	SD	Minimum (g)	Maximum (g)	p-value
Group A	30	2330	0.48	2	3	<0.0001
Group B	30	3400	0.50	3	4	

Paracetamol consumption during the first 24 hours was significantly lower in Group A.

**Table 4. Second rescue analgesic drugs administered**

Drug	Frequency	Percentage (%)
Tramadol	52	86.67
Diclofenac	8	13.33

Tramadol was the predominant second rescue analgesic used in the study population.

**Table 5. Distribution of second rescue analgesics between groups**

Drug	Group A	Group B	Total
Diclofenac	9	4	13
Tramadol	19	24	43

Tramadol use was higher in Group B, whereas diclofenac use was relatively more frequent in Group A.

**Table 6. Comparison of cumulative analgesic consumption**

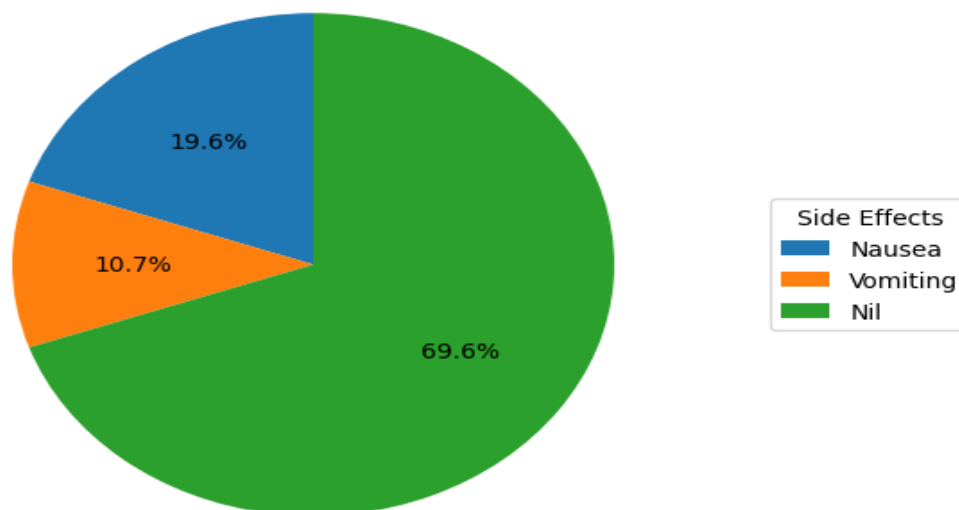
Group	Paracetamol (mg)	Diclofenac (mg)	Tramadol (mg)
Group A	2330	102.27	113.16
Group B	3440	150	266.67

**Table 7. Mean total analgesic consumption in 24 hours**

Group	N	Mean (mg)	SD	Minimum	Maximum	p-value
Group A	30	109.17	34.42	50	150	<0.0001
Group B	30	243.33	58.33	150	350	

Total analgesic consumption over 24 hours was significantly lower in Group A compared to Group B.

### Overall Distribution of Postoperative Side Effects



Postoperative nausea and vomiting were significantly more frequent in Group B ( $\chi^2 \approx 9.97$ ,  $p < 0.01$ ). No patients in either group developed local anaesthetic systemic toxicity, neuropraxia, hematoma, or residual motor blockade.

### DISCUSSION

Effective postoperative pain control following hip arthroplasty plays a crucial role in facilitating early mobilization, functional recovery, and patient satisfaction. In the present prospective observational study, the addition of an ultrasound-guided Pericapsular Nerve Group (PENG) block to spinal anaesthesia resulted in superior early and mid-postoperative analgesia, prolonged duration of analgesia, reduced postoperative analgesic consumption, and fewer adverse effects when compared with spinal anaesthesia followed by conventional analgesia.

Postoperative pain scores assessed using the Visual Analogue Scale (VAS) demonstrated that both groups had comparable pain relief at 2 hours, which can be attributed to the residual effect of spinal anaesthesia. However, from 4 to 12 hours postoperatively, patients who received the PENG block experienced significantly lower pain scores. The difference was most pronounced at 6 hours, where the mean VAS score in the PENG group was  $0.9 \pm 1.16$ , compared to  $3.7 \pm 2.14$  in the control group. These findings are in accordance with the randomized placebo-controlled trial conducted by **Zheng et al.(1)**, who reported significantly lower postoperative pain scores in patients receiving a PENG block for total hip arthroplasty. Similar reductions in early postoperative pain have been reported by **Hu et al.(2)** and **Domagalska et al.(8)**, supporting the analgesic efficacy of the PENG block during the period when postoperative pain is typically most severe. The convergence of pain scores at 24 and 48 hours in the present study suggests that the analgesic benefit of the PENG block is primarily confined to the early and mid-postoperative period, a finding that is consistent with previous clinical observations.

The duration of postoperative analgesia was significantly prolonged in patients receiving the PENG block, with a mean duration of  $7.13 \pm 1.01$  hours compared to  $5.13 \pm 1.01$  hours in the control group. This prolonged pain-free interval delayed the need for rescue analgesia and contributed to improved patient comfort in the immediate postoperative period. Comparable findings were reported by **Duan et al.(3)**, who demonstrated longer analgesic duration with continuous PENG block when compared to fascia iliaca compartment block, and by **Mysore et al.(4)**, who observed prolonged analgesia and reduced opioid requirements in their retrospective analysis of patients undergoing total hip arthroplasty.

A significant reduction in postoperative analgesic consumption further reinforces the effectiveness of the PENG block observed in this study. Total 24-hour analgesic consumption was markedly lower in the PENG group ( $109.17 \pm 34.42$  mg) compared to the control group ( $243.33 \pm 58.33$  mg). In addition, paracetamol consumption during the first 24 hours was significantly reduced in patients who received the PENG block. These findings align with those reported by **Bravo et al.(5)** and **Abdou and Lotfy(9)**, who demonstrated reduced postoperative analgesic requirements in patients receiving PENG block. The reduction in systemic analgesic use is clinically important, particularly in elderly patients, as excessive opioid and NSAID use has been associated with adverse effects that may delay recovery and rehabilitation (17,19).

Postoperative adverse effects, particularly nausea and vomiting, were significantly less frequent in patients receiving the PENG block. In the present study, nausea and vomiting were predominantly observed in the control group, whereas the majority of patients in the PENG group experienced no postoperative side effects. This finding is likely related to reduced systemic analgesic consumption and is consistent with the observations of **Aygun et al.(6)** and **Morrison et al.(7)**, who highlighted the opioid-sparing benefits of the PENG block in hip surgery. Importantly, no patients in either group developed local anaesthetic systemic toxicity, neuropraxia, hematoma, or residual motor blockade, underscoring the safety of the PENG block when performed under ultrasound guidance.

Intraoperative hemodynamic parameters, including heart rate, blood pressure, and oxygen saturation, remained stable and comparable between the two groups throughout the observation period. This suggests that the addition of the PENG block did not adversely affect intraoperative hemodynamic stability. The motor-sparing nature of the PENG block, as described in anatomical and clinical studies by **Zhu(11)** and **Tomlinson et al.(16)**, may further contribute to its clinical utility by facilitating early mobilization without compromising analgesic efficacy. Preservation of motor function is particularly advantageous in hip arthroplasty patients, where early ambulation is critical for functional recovery and prevention of postoperative complications (12,19).

Overall, the findings of the present study demonstrate that ultrasound-guided PENG block is an effective and safe adjunct to spinal anaesthesia for postoperative analgesia in patients undergoing hip arthroplasty. By providing superior early postoperative pain relief, prolonging the duration of analgesia, reducing postoperative analgesic requirements, and minimizing adverse effects, the PENG block represents a valuable component of multimodal analgesic strategies for hip arthroplasty.

## CONCLUSION

The findings of this prospective observational study demonstrate that the ultrasound-guided Pericapsular Nerve Group (PENG) block is an effective and safe adjunct to spinal anaesthesia for postoperative analgesia in patients undergoing hip arthroplasty. Patients receiving the PENG block experienced significantly lower postoperative pain scores during the early and mid-postoperative period (4–12 hours), a longer duration of analgesia ( $7.13 \pm 1.01$  hours vs  $5.13 \pm 1.01$  hours), and a substantial reduction in total 24-hour analgesic consumption ( $109.17 \pm 34.42$  mg vs  $243.33 \pm 58.33$  mg) compared with conventional postoperative analgesia.

In addition to improved analgesic efficacy, the PENG block was associated with a lower incidence of postoperative nausea and vomiting, reflecting its analgesic-sparing effect and favorable safety profile. Intraoperative hemodynamic stability was maintained, and no block-related complications or motor deficits were observed, underscoring the reliability and safety of the technique when performed under ultrasound guidance.

Overall, the PENG block provides meaningful clinical benefits by improving postoperative pain control while preserving motor function and reducing reliance on systemic analgesics. Its incorporation into multimodal analgesic protocols may enhance early recovery and patient comfort following hip arthroplasty under regional anaesthesia.

**Conflict of interest:** Nil

**Funding:** Nil

## REFERENCES

1. Zheng J, Pan D, Zheng B, Ruan X. Preoperative pericapsular nerve group (PENG) block for total hip arthroplasty: a randomized, placebo-controlled trial. *Regional Anesthesia and Pain Medicine*. 2022;47(3):155–160.
2. Hu J, Wang Q, Hu J, Kang P, Yang J. Efficacy of ultrasound-guided pericapsular nerve group (PENG) block combined with local infiltration analgesia on postoperative pain after total hip arthroplasty: a prospective, double-blind, randomized controlled trial. *The Journal of Arthroplasty*. 2023;38(6):1096–1103.
3. Duan L, Zhang L, Shi CG, Huang LG, Ao H, Wang ZP, Deng Y, Sun ML. Comparison of continuous pericapsular nerve group (PENG) block versus continuous fascia iliaca compartment block on pain

- management and quadriceps muscle strength after total hip arthroplasty: a prospective, randomized controlled study. *BMC Anesthesiology*. 2023;23(1):233.
4. Mysore K, Sancheti SA, Howells SR, Ballah EE, Sutton JL, Uppal V. Postoperative analgesia with pericapsular nerve group (PENG) block for primary total hip arthroplasty: a retrospective study. *Canadian Journal of Anesthesia*. 2020;67:1673–1674.
  5. Bravo D, Aliste J, Layera S, Fernández D, Erpel H, Aguilera G, Arancibia H, Barrientos C, Wulf R, León S, Brañes J. Randomized clinical trial comparing pericapsular nerve group (PENG) block and periarticular local anesthetic infiltration for total hip arthroplasty. *Regional Anesthesia and Pain Medicine*. 2023;48(10):489–494.
  6. Aygun H, Tulgar S, Yigit Y, Tasdemir A, Kurt C, Genc C, Bilgin S, Senoglu N, Koksal E. Effect of ultrasound-guided pericapsular nerve group (PENG) block on pain during patient positioning for central nervous blockade in hip surgery: a randomized controlled trial. *BMC Anesthesiology*. 2023;23(1):316.
  7. Morrison C, Brown B, Lin DY, Jaarsma R, Kroon H. Analgesia and anesthesia using the pericapsular nerve group block in hip surgery and hip fracture: a scoping review. *Regional Anesthesia and Pain Medicine*. 2021;46(2):169–175.
  8. Domagalska M, Ciftci B, Reysner T, Kolasiński J, Wieczorowska-Tobis K, Kowalski G. Pain management and functional recovery after pericapsular nerve group (PENG) block for total hip arthroplasty: a prospective, randomized, double-blinded clinical trial. *Journal of Clinical Medicine*. 2023;12(15):4931.
  9. Abdou AA, Lotfy LA. Pericapsular nerve group block for postoperative analgesia in patients undergoing total hip arthroplasty. *Zagazig University Medical Journal*. 2024;30(8.1):4003–4013.
  10. Ferré F, Rey J, Bosch L, Menut R, Ferrier A, Ba C, Halimi C, Collinson I, Tissot B, Labaste F, Reina N. Pericapsular nerve group (PENG) block combined with local infiltration analgesia is not superior to local infiltration analgesia for the management of postoperative pain after primary elective total hip arthroplasty: a prospective, randomized, controlled, single-blind trial. *Heliyon*. 2024;10(13):e—.
  11. Zhu Z. Surgical anatomy of the hip joint. In: *Hip Surgery: A Practical Guide*. Singapore: Springer; 2020. p. 1–15.
  12. Flack NA, Nicholson HD, Woodley SJ. The anatomy of the hip abductor muscles. *Clinical Anatomy*. 2014;27(2):241–253.
  13. Moore AM, Bettlach CR, Tung TT, West JM, Russo SA. Lower extremity nerve transfers in acute flaccid myelitis patients: a case series. *Plastic and Reconstructive Surgery – Global Open*. 2021;9(7):e3699.
  14. Gardner E. Physiology of movable joints. *Physiological Reviews*. 1950;30(2):127–176.
  15. Gerhardt MB, Logishetty K, Meftah M, Ranawat AS. Arthroscopic and open anatomy of the hip. In: Sekiya JK, Safran MR, Ranawat AS, et al., editors. 2010. p. 9–22.
  16. Tomlinson J, Ondruschka B, Prietzel T, Zwirner J, Hammer N. A systematic review and meta-analysis of the hip capsule innervation and its clinical implications. *Scientific Reports*. 2021;11(1):5299.
  17. Li JW, Ma YS, Xiao LK. Postoperative pain management in total knee arthroplasty. *Orthopaedic Surgery*. 2019;11(5):755–761.
  18. Pierannunzii LM. Thigh pain after total hip replacement: a pathophysiological review and a comprehensive classification. *Orthopedics*. 2008;31(7):691.
  19. Aasvang EK, Luna IE, Kehlet H. Challenges in postdischarge function and recovery: the case of fast-track hip and knee arthroplasty. *British Journal of Anaesthesia*. 2015;115(6):861–869.