Hip arthroplasty under pericapsular nerve group blocks combined with local anesthesia: a report on three different surgical techniques

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Abstract

Hip arthroplasty and endoprosthesis surgery typically utilize general or spinal anesthesia, but regional techniques like the PENG block offer potential analgesic benefits. This report presents three cases in which a modified ultrasound-guided pericapsular infiltration technique is used as the only technique for hip surgery.

Three patients undergoing hip arthroplasty/endoprosthesis surgery with different approaches (direct anterior, lateral, and posterolateral) received ultrasound-guided anterior and posterior pericapsular injections (A-PENG and PONG) and additional local anesthetic infiltration tailored to the surgical approach. All patients experienced successful intraoperative anesthesia and adequate postoperative analgesia within 24 hours, with no motor block. The technique was adaptable to different approaches and patient characteristics.

This case series suggests the feasibility and potential benefits of the pericapsular nerve blocks as a regional anesthesia option for hip surgery. Further research is needed to compare its efficacy, safety, and cost-effectiveness with other techniques in larger, controlled studies.

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Key words: hip replacement arthroplasty; nerve block; conduction anesthesia; local anesthesia; regional anesthesia; PENG block.

Conflict of interest: the authors declare no potential conflict of interest.

Ethics approval and consent to participate: no ethical committee approval was required for this case report by the Department because this article does not contain any studies with human participants or animals. Informed consent was obtained from the patients included in this study.

Consent for publication: the patients gave their written consent to use their personal data for the publication of this case report and any accompanying images.

Availability of data and materials: all data underlying the findings are fully available.

Received: 5 April 2025.
Accepted: 16 May 2025.

Licensee PAGEPress, Italy
Advances in Anesthesia and Pain Medicine 2025; 1:45
doi:10.4081/aapm.2025.45

Introduction

Hip fracture is an increasingly painful condition that primarily affects adults over 65 years old, predominantly women, and poses a potential life-threatening risk.[1,2] Consequently, early surgical management of femoral fractures is crucial for improving survival and reducing the risk of complications.[3]

As of now, two primary anesthetic options exist for hip fracture repair surgery: spinal and general anesthesia, with the former demonstrating enhanced postoperative outcomes, particularly in high-risk patients.[4] However, in such patients, spinal anesthesia may negatively impact hemodynamic stability due to its sympatholytic effect.[5]

Since 2018, the pericapsular nerve group (PENG) block has been described as an effective technique for pain management in hip fracture patients without affecting motor function when compared to femoral nerve block, lumbar plexus block, or fascia iliaca block.[6-10] This technique provides adequate pain control while preserving the motor branches from the femoral, obturator, and accessory obturator nerves, although it does not offer posterior capsule analgesia. Consequently, since 2019, we have implemented a posterior ultrasound-guided pericapsular infiltration (PONG) along with an anterior ultrasound-guided pericapsular infiltration (A-PENG) as part of a multimodal analgesic regimen, not only for patients undergoing hip fracture surgery but also for elective hip replacement procedures.[11,12]

In the past year, a refined technique has enabled us to utilize these pericapsular blocks as the primary anesthetic method for managing hip endoprosthesis surgeries, complemented by local anesthetic skin infiltration and sedation.

We aim to share our experience and outline the adaptation and implementation of these techniques in our first three cases involving patients undergoing total hip replacement (THR) through the direct anterior approach (DAA), endoprosthesis surgery under the lateral approach (LAA), and THR through the posterolateral approach (PLA), respectively.

Case Reports

Case 1

A 49-year-old patient with a body mass index (BMI) of 28.4 and hypertension controlled by ramipril/amlodipine was scheduled for left THR under DAA.

An early rehabilitation was accorded previously, so a local/regional anesthesia was chosen: A-PENG + PONG + local anesthesia (LA), with sedation using propofol.

Three 20 mL syringes were prepared:

1. Total of 20 mL of plain anesthetics: 10 mL 2% mepivacaine + adrenaline 1:200000 +10 mL 0.75% ropivacaine + 2 mg dexamethasone (A-PENG).
2. Total of 10 mL of plain anesthetics: 5 mL 2% mepivacaine + adrenaline 1:200000 + 5 mL 0.75% ropivacaine + 1 mg dexamethasone (PONG).
3. Total of 20 mL of diluted anesthetics: 5 mL 2% mepivacaine + adrenaline 1:200000 + 5 mL 0.75% ropivacaine + 1 mg dexamethasone + 10 mL saline (LA).

Following patient monitoring and supplemental O_2 administration, a premedication with a cumulative dose of 50 µg of fentanyl and 3 mg of midazolam was administered prior to regional anesthesia.

In supine position, the A-PENG was performed: a curvilinear probe was placed anteriorly along the long axis of the neck of the femur. With this scan, a view of the acetabulum, the head, and the neck of the femur should be obtained, as well as a view of the overlying hip capsule and the iliopsoas muscle (IPM) above (Figure 1).

After careful disinfection, an 80 mm echogenic needle (Sonoplex II, Pajunk GmbH, Germany) was inserted in plane, from caudal to cranial. The injection of 10 to 15 mL of plain anesthetic was delivered above the capsular plane, below the IPM, and the anesthetic diffusion along the capsular dome plane was carefully observed.

The probe was then moved laterally, pivoting around the femur neck, to obtain a more lateral scan of the same pericapsular plane. The remaining 5 to 10 mL of anesthetic were injected in the pericapsular plane (Figure 2).

After a few minutes, the patient was turned to the contralateral side, and the PONG was performed.

The curvilinear probe was placed posteriorly and transversely between the greater trochanter (GT) and the ischial tuberosity (IT) (Figure 3A). These two bony landmarks, the gluteus maximus (GM), the sciatic nerve (SN), and the quadratus femoris (QF), were identified. After disinfection, a second puncture was performed,

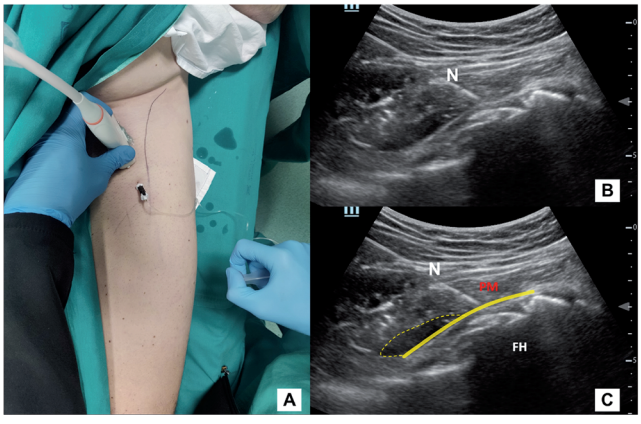

Figure 1. A-PENG, first injection. In supine position, the A-PENG is performed: a curvilinear probe is placed anteriorly along the long axis of the neck of the femur (A). With this scan, a view of the acetabulum, the head, and the neck of the femur should be obtained, as well as a view of the overlying hip capsule and the PM above (B). The needle is inserted in plane, from caudal to cranial. The injection of 10 to 15 mL of plain anesthetic is performed above the capsular plane, below the PM, being careful to observe the anesthetic diffusion along the capsular dome plane (C).
N, needle; PM, psoas muscle; FH, femur head; yellow line (and yellow dotted line), anesthetic diffusion above the hip capsule.

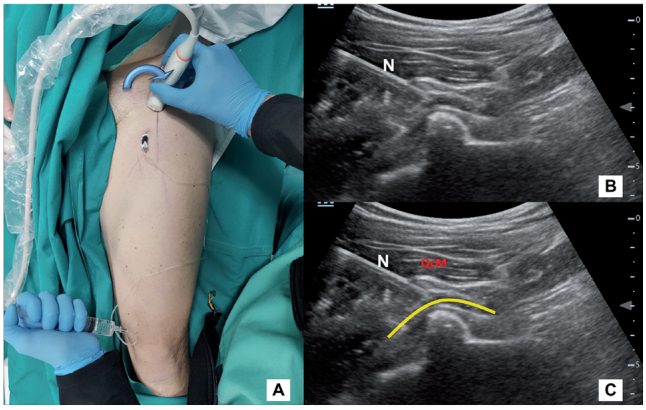

Figure 2. A-PENG, second injection. The probe is pivoted around the femur neck to obtain a more lateral scan of the same pericapsular plane (A,B). Here, the remaining 5 to 10 mL of anesthetic are injected in the pericapsular plane (B,C).
N, needle; QcM, quadriceps muscle; yellow line, anesthetic diffusion above the hip capsule.

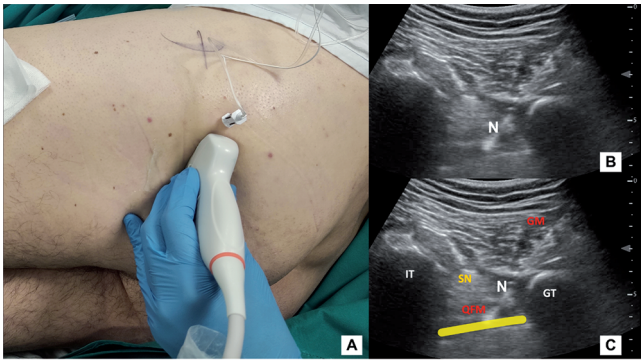

Figure 3. PONG. The patient is turned to the contralateral side. The curvilinear probe is placed posteriorly and transversely between the GT and IT (A). The GT, IT, GM, SN, and QFM are identified. The needle is inserted in plane, from lateral to medial, being careful to avoid the SN, targeting the plane below the QF. Here, 10 mL of plain local anesthetic are injected (B,C).
N, needle; GM, gluteus maximus muscle; QFM, quadratus femoris muscle; IT, ischial tuberosity; GT, greater trochanter; SN, sciatic nerve; yellow line, anesthetic diffusion above the hip capsule.

inserting the needle in the plane from lateral to medial, being careful to avoid the SN, and targeting the plane below the QF. Here, 10 mL of plain local anesthetic were injected (Figure 3 B,C).

A correct diffusion plane under the muscle should elevate the latter. An injection within the muscle body could result in a diffusion towards the SN, resulting in an SN block.

Before performing the last injection of LA, the surgeon was asked to draw the incision line. After careful disinfection, the skin incision line and a fan-shaped subcutaneous infiltration of the remaining 20 mL of diluted LA were performed.

The patient was then transferred to the operating theater, and TCI-propofol sedation was initiated. The patient lost consciousness at an effector site target concentration of 3 µg/mL, and a further 50 µg of fentanyl was administered prior to the incision; spontaneous ventilation was maintained. Surgery began 50 minutes after the first block and lasted for 110 minutes.

At the end of the surgery, the patient was transferred to the post-anesthesia care unit (PACU) and evaluated for pain and motility.

No lower limb motor block was present. Due to some residual pain, a total amount of 100 µg of fentanyl and 10 mg of morphine were administered.

The patient was transferred to the ward without pain 60 minutes after arrival in the PACU. The postoperative analgesic regimen started and consisted of paracetamol 1000 mg + ketorolac 30 mg every 8 hours for 3 days, *plus* tapentadol 50 mg as a rescue dose.

After 24 hours, the patient reported no pain during that time, underwent early rehabilitation, and did not request rescue doses.

Case 2

An 84-year-old male patient, classified as ASA status III, with a BMI of 27.6, presented with a femur fracture and was scheduled for right hip endoprosthesis surgery using a lateral approach in the supine position. His comorbidities included a previous stroke, past STEMI, stable coronary artery disease, paroxysmal atrial fibrillation, left bundle branch block, and seasonal affective disorder. The patient was receiving pharmacological therapy with bisoprolol, furosemide, apixaban, alprazolam, atorvastatin, levodopa/carbidopa, selegiline, and amiodarone. Apixaban was not suspended in due time due to the unscheduled nature of the surgery and the recommendation to perform it within 48 hours. After careful discussion with the patient and the surgeon, general and spinal anesthesia were deemed to be too impactful on the patient's hemodynamics; furthermore, spinal anesthesia was not feasible due to inadequate apixaban suspension timing, so a local/regional anesthesia was chosen instead: an ultrasound-guided A-PENG + PONG + LA and sedation with propofol.

After patient monitoring and supplemental O_2 administration, a premedication with a cumulative dose of 100 µg of fentanyl and 2 mg of midazolam was administered prior to regional anesthesia.

Three 20 mL syringes were prepared as previously described. In supine position, a two-injection A-PENG was performed accordingly.

After a few minutes, the patient was turned to the contralateral side, and the PONG was performed. For this patient, for the PONG block, only 7 mL were used. The probe was then moved to show the trochanteric insertion of the gluteus medius. The remaining 3 mL of PONG were diluted with 3 mL of saline and injected close to the muscle trochanteric insertion. The last injection of LA was performed, adapting to the LAA incision line.

The patient was then transferred to the operating theater, and a TCI-propofol sedation was started. The patient lost consciousness at an effector site target concentration of 3 µg/mL, which was soon after lowered to 1 µg/mL and continued throughout surgery; spontaneous ventilation was maintained. Surgery started 35 minutes after the first block and lasted 75 minutes.

At the end of the surgery, the patient was transferred to PACU and evaluated for pain and motility.

No pain was recorded, and no lower limb motor block was present: the patient could move the ankle, knee, and hip. No further analgesics were necessary in the perioperative period.

The patient was transferred to the ward 30 minutes after arrival in PACU. The postoperative analgesic regimen started and consisted of paracetamol 1000 mg + ketorolac 30 mg every 8 hours for 3 days, *plus* tapentadol 50 mg as a rescue dose.

After 24 hours, the patient reported no pain and did not request any rescue doses.

Case 3

A 62-year-old female patient presented with a left femur neck fracture. She was scheduled for THR under PLA in lateral position. The patient had no comorbidities (ASA status classification: I), a BMI of 20.3, and she was currently taking no medications.

The patient presented anxiety issues regarding surgery and the type of anesthesia. After careful discussion with the surgeon, a local/regional anesthesia was decided accordingly: A-PENG + PONG + LA and sedation with propofol.

After patient monitoring, a premedication with a cumulative dose of 100 µg of fentanyl and 3 mg of midazolam was administered.

The A-PENG + PONG + LA was performed as previously described with two differences: the remaining 3 mL of PONG diluted with 3 mL of saline were injected within the body of the piriformis muscle close to its trochanteric insertion, and the LA infiltration was modified according to the different PLA incision line.

In the operating theater, supplemental O_2 was administered, and a 3 µg/mL TCI-propofol sedation was started. Surgery started 35 minutes after the first block and lasted 80 minutes, also involving a proximal femur cerclage around the prosthetic stem.

At the end of the surgery, the patient was transferred to PACU and evaluated for pain and motility.

No pain was recorded, and no lower limb motor block was present: the patient was able to move ankle, knee, and hip. No further analgesics were necessary.

The patient was transferred to the ward 30 minutes after arrival in PACU. The postoperative analgesic regimen started and consisted of paracetamol 1000 mg + ketorolac 30 mg every 8 hours for 3 days, *plus* tapentadol 50 mg as rescue dose.

After 24 hours, the patient reported no pain, and no rescue doses were requested.

Discussion

Hip replacements are commonly performed under general or spinal anesthesia. It is worth noting that both are suitable for early recovery and rehabilitation after surgery. In the first case, the choice of anesthetic was influenced by the fact that the surgery was scheduled late in the afternoon, allowing for the earliest possible initiation of active rehabilitation.

In recent years, the PENG block has been increasingly utilized for analgesic purposes in both femur fractures and hip replacements, yielding positive outcomes.[13-15]

These procedures were conducted employing a modified ultrasound-guided pericapsular infiltration with LA and sedation, thus avoiding both general and spinal anesthesia.

Several similarities exist among the A-PENG, the PENG block,

and the iliopsoas plane block, all aiming to anesthetize the sensitive fibers innervating the anterior hip capsule. Despite the more cranial performance of the PENG block, the local anesthetic eventually spreads along the capsular plane, where the A-PENG is performed.[8,16,17] For this report, nomenclature adjustments were made to prevent confusion between the techniques.

In contrast, the PONG technique shares similarities with the one described by Vermeylen *et al.*, where the procedure is performed on the lateral side with both the hip and knee flexed at a 90° angle.[18] However, for fractured patients, we prioritize minimizing hip movement, so an approach with minimal hip flexion is preferred.

As previously mentioned, this technique is used in our hospital for elderly patients undergoing endoprosthesis surgery with DAA. In these cases, LA is administered based on the specific skin incision site.

This is our initial application in surgeries with approaches different from DAA, such as those where the lateral insertion of the piriformis muscle and external rotators was resected for the posterolateral approach, as well as the distal insertion of the gluteus medius for the lateral approach.

During DAA, blunt dissection is performed until reaching the hip capsule, minimizing muscle trauma. Conversely, posterolateral and lateral approaches necessitate muscle detachment to adequately expose the hip joint. This raised a main concern: the potential for inadequate anesthesia during the muscle sectioning process. To address this, PONG was integrated with injections targeting the lateral insertion of the muscles intended for sectioning.

Limitations of the technique

Case 1 presented with some residual pain in the PACU, necessitating treatment with analgesics. This case was highlighted as it involved the first patient to consent to the publication after undergoing this technique. In contrast, subsequent patients who underwent hip endoprosthesis surgery with the DAA and PENG+PONG technique did not require additional analgesics in the PACU. To date, in our hospital, more than 30 patients have received this technique without issues. We hypothesized that, in the first case, the patient experienced pain from the thigh muscle stretch during DAA surgery, attributed to his young age, male gender, and higher-than-average muscle tone.

Another concern emerged during the second patient's surgery when an unplanned femoral cerclage was required. Ultimately, the cerclage area was successfully covered by the pericapsular infiltration.

In the third case, both the patient and surgeon were informed of the potential risk of a sciatic nerve block due to the proximity of the second posterior injection. The SN runs just distal to the piriformis muscle, so an inadvertent injection below the muscle, rather than within its lateral insertion, could result in an SN block. However, it is likely that ultrasound guidance, the nerve's more medial location, and the small volume of LA used helped prevent the nerve blockade.

A similar concern could arise if an inadvertent intramuscular injection occurs within the QF muscle, rather than below it, or if volumes exceeding 10 mL are used. In such cases, an SN block could occur.

Conclusions

All three surgeries proceeded uneventfully. The A-PENG/PONG + LA were easily performed in all patients, delivering satisfactory intraoperative anesthesia and adequate postoperative analgesia within 24 hours. This technique has been successfully employed for total hip replacement with a posterolateral approach and for hip endoprosthesis with a lateral approach, incorporating appropriate PONG modifications. No motor impairment occurred in the perioperative period, enabling early mobilization without pain in all cases.

Patients expressed satisfaction with the technique and consented to the publication of their cases.

What is known?

General or spinal anesthesia are the standard approaches for hip arthroplasty and endoprosthesis surgery.

What is new?

- This study demonstrates the successful use of a modified ultrasound-guided pericapsular nerve block technique as the sole anesthetic method for hip surgery in three patients.
- The technique provided adequate intraoperative anesthesia and postoperative analgesia within 24 hours, with no motor block.
- This technique appears adaptable to different surgical approaches and patient variations.

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