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PENG block associated with dexmedetomidine sedation for intramedullary femoral fixation in high-risk elderly patients: a case series and review of the literature

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Abstract. – BACKGROUND: Hip fracture is a major cause of hospitalization among the elderly population. The standard surgical treatment involves early repair to reduce mortality and morbidity. One type of treatment in the case of intertrochanteric and subtrochanteric fractures is intramedullary nailing, as it decreases soft tissue damage and permits early weight bearing. The most common anesthesia technique combines spinal anesthesia with a peripheral block. In cases where spinal anesthesia is contraindicated, general anesthesia is preferred. However, both techniques can lead to significant complications, especially in patients with multiple comorbidities. Pain management after hip surgery, particularly in elderly and frail individuals, poses a challenge. The pericapsular nerve group block (PENG) targets the innervation of the anterior portion of the hip joint and is increasingly used for pain management related to hip surgery.

CASE SERIES: This paper presents a case series of three elderly patients who underwent pericapsular nerve group block (PENG) block combined with dexmedetomidine sedation for intramedullary femoral fixation.

CONCLUSIONS: The PENG block can be effectively used as the sole anesthetic technique for managing elderly patients undergoing intramedullary femoral fixation while on antiplatelet drugs. This procedure effectively controlled pain during both the surgical and postoperative periods. The addition of dexmedetomidine for sedation enables comfortable and safe procedures, minimizing the risk of perioperative neurocognitive dysfunctions and without adverse effects on cardiorespiratory function.

Key Words:
Nerve block, Pain, Pericapsular nerve group block, Ultrasonography, Hip fracture.

Abbreviations

Peng: Pericapsular nerve group block; HF: Hip fracture; GA: General anesthesia; NA: Central neuraxial anesthesia; RA: Regional analgesia; FN: Femoral nerve; ON: Obturator nerve; AON: Accessory obturator nerve; NIBP: Non-invasive blood pressure monitoring; BIS: Bispectral index; RASS: Richmond Agitation-Sedation Scale; AIIS: Anterior inferior iliac spine; IPE: Ileopubic eminence; BPS-NI: Behavioral Pain Scale for non-intubated patients; NPRS: Numerical Pain Rating Scale; IQR: interquartile range; ASA: American Society of Anesthesiologists; COPD: Chronic Obstructive Pulmonary Disease; HB: Hemoglobin; MAC: Monitored anesthesia care.

Background

Hip fracture (HF) refers to a fracture in the proximal part of the femur, occurring predominantly in older adults, particularly women. It is a leading cause of hospitalization among the elderly population and is associated with high mortality rates[1-3]. Surgical treatment, such as hip arthroplasty or internal fixation, is recommended for most HF cases, preferably within 48 hours of the trauma[2,4,5].

The optimal anesthesia technique for HF surgery is still debated, with attention focused on whether avoiding general anesthesia (GA) can improve outcomes[6-12]. Central neuraxial anesthesia (NA), while commonly used, requires careful consideration in patients on antiplatelet and anticoagulant therapy due to the increased risk of spinal-epidural hematoma[13]. HF surgery often leads to postoperative pain, which can hinder recovery.

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Poor pain control after surgery is a well-known cause of increased risk of postoperative delirium and cognitive dysfunction. A multimodal approach to pain management is recommended[14-27], and various regional analgesia (RA) techniques have been proposed[28-35]. However, blocking the anterior capsule of the hip joint with conventional techniques can be challenging[36,37]. The pericapsular nerve group (PENG) block, introduced in 2018[38], provides motor-sparing analgesia and targets the articular branches of the femoral nerve (FN), obturator nerve (ON), and accessory obturator nerve (AON). The use of pericapsular nerve group block (PENG) block as the sole anesthetic technique for hip surgery is not well-studied[39-48].

Dexmedetomidine, an alpha-2 adrenergic receptor agonist, is commonly used for intraoperative sedation in RA techniques, due to its anxiolytic, sedative, and analgesic actions, with minimal respiratory depression and hemodynamic effects[49-56].

The aim of this case series was to evaluate the efficacy and safety of the PENG block as the sole anesthetic technique for elderly patients undergoing intramedullary femoral fixation.

Case Series

The patients were admitted for femur fracture to the Orthopedic ward of IRCCS Fondazione Policlinico Universitario Agostino Gemelli in Rome, Italy, in June 2021.

The Ethics Institutional Review Committee approved the study (approval number ID 3993). Patients included in the study expressed their consent to participate before the inclusion. Standard perioperative monitoring [non-invasive blood pressure monitoring (NIBP), 3-lead ECG, peripheral oxygen saturation (SpO_2), and bispectral index (BIS)] was conducted. The patients received intravenous dexmedetomidine sedation titrated to a target sedation level defined by the Richmond Agitation-Sedation Scale (RASS) between -2 and -3.

Therefore, an ultrasound-guided PENG block was performed with the patient in the supine position. After adequate skin disinfection with a surgical solution (ChloraPrep®, Carefusion, 244 LTD, UK), a linear high-frequency ultrasound probe (SonoSite HFL 38/6-13MHz, Fujifilm SonoSite Inc., Bothell, WA, USA) was placed transversely over the anterior inferior iliac spine (AIIS) and then rotated approximately 45 degrees. The iliopubic eminence (IPE), iliopsoas muscle and tendon, femoral artery, and pectineus muscle were visualized. A 22-gauge, 80-mm needle (Stimuplex Ultra, B Braun, Melsugen, Germany) was inserted from lateral to medial using an in-plane technique. After confirming negative aspiration, a local anesthetic solution was injected into the musculofascial plane between the psoas tendon anteriorly and the pubic ramus posteriorly (Figure 1). A total volume of 20 ml of 0.5% ropivacaine was administered.

After positioning the patient on the operating table, the surgeon injected 5 ml of 2% mepivacaine into the skin incision site to block the sensory afferences on the lateral side of the thigh.

The PFNA nail Synthes® (Proximal Femoral Nail Antirotation), was used for every patient.

Patient discomfort during the procedure was assessed using the Behavioral Pain Scale for

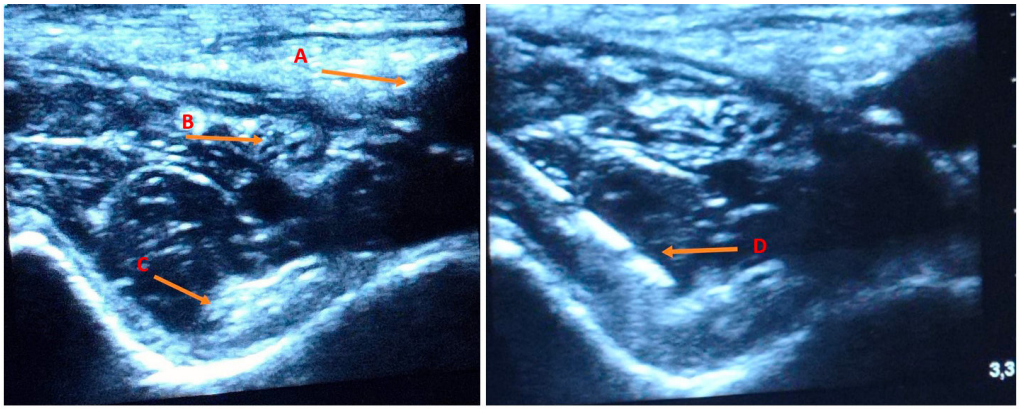

Figure 1. Ultrasound image during Pericapsular nerve group block (PENG). On the left side the first arrow at the top indicates the femoral artery (A), the second one indicates the femoral nerve (B), and the bottom arrow indicates the iliopsoas tendon (C). On the right side the arrow indicates the image of needle insertion (D).

non-intubated patients (BPS-NI), which ranges from 3 (no pain) to 12 (maximum level of pain). In the case of BPS-NI > 6, boluses of 5 mcg sufentanil and/or 10 mg of propofol were administered to maintain a depth of sedation defined as a BIS between 60 and 75.

Perioperative bleeding was estimated by changes in hemoglobin concentration and the number of packed red cells transfused.

Cumulative doses of administered drugs (anesthetics, opioids, fluids, vasopressors, and inotropes) and any adverse events were assessed and reported.

Postoperative pain was managed with acetaminophen using an around-the-clock dosing scheme (1 g every 8 hours) for the first two postoperative days. Tramadol 100 mg was administered as rescue therapy Numerical Pain Rating Scale (NPRS) if it was ≥ 4.

The intensity of pain was assessed before and at the end of surgery and three times a day in the orthopedic ward using the verbal NPRS ranging from 0 to 10, where 0 represents no pain, and 10 represents the worst pain imaginable.

Numerical data are presented as absolute values or median (interquartile range, IQR). Data analysis was performed using R (R Foundation for Statistical Computing, Vienna, Austria; version 4.1.2).

Case One

A 91-year-old female weighing 58 kg, with a BMI of 26 kg · m^{-2} and an American Society of Anesthesiologists (ASA) status III, was diagnosed with a right pertrochanteric femur fracture. She underwent intramedullary femur nailing using the Proximal Femoral Nail Antirotation nail Synthes® (PFNA), and a PENG block under dexmedetomidine sedation was chosen as the anesthesia method. Her medical history included a myocardial infarction treated with percutaneous coronary intervention and two drug-eluting stents on the left coronary artery two months prior to the femur fracture, as well as arterial hypertension and Chronic Obstructive Pulmonary Disease (COPD) treated with aspirin, clopidogrel, beta-blockers, and a phosphodiesterase-4 inhibitor. Dual antiplatelet therapy could not be interrupted before surgery.

Intraoperatively, the target RASS score was achieved with a dexmedetomidine infusion rate of 1 mcg/kg/h. Sufentanil 10 mcg was administered during fracture reduction, and the surgery lasted 55 minutes. The intraoperative period was uneventful, with no significant hemodynamic fluctuations. The median blood pressure was 80 mmHg (IQR 78-75), and the median heart rate was 59 bpm (IQR 57-60). The preoperative hemoglobin (Hb) level was 11.3 g/dl, which decreased to 6.3 g/dl at the end of surgery. During the procedure, the patient received 500 mL of 5% human serum albumin, and 2 units of packed red cells were transfused at the end of surgery.

The preoperative NPRS score was 7, which decreased to 1 at the end of surgery. Postoperative pain was managed solely with acetaminophen, and no rescue therapy was needed. Rehabilitation was initiated on the first postoperative day, and the patient was discharged after 9 days with good functional recovery.

Case Two

A 95-year-old female weighing 53 kg, with a height of 1.60 m and a BMI of 21 kg · m^{-2}, and an ASA status of III, was diagnosed with a left intertrochanteric femur fracture. She underwent intramedullary femur nailing with PFNA nail Synthes®. Her medical history included hypertension treated with calcium channel blockers and diuretics, and poorly controlled type II diabetes mellitus treated with biguanides. She also had a recent percutaneous coronary intervention, and antiplatelet therapy could not be interrupted.

During surgery, the target RASS score was achieved with a dexmedetomidine infusion rate of 0.8 mcg/kg/h. Sufentanil 5 mcg was administered during fracture reduction, and the surgery lasted 48 minutes. The intraoperative period was uneventful, with no significant hemodynamic fluctuations. The median blood pressure was 72 mmHg (IQR 68-77), and the median heart rate was 63 bpm (IQR 55-67). Total ephedrine 10 mg was administered. The preoperative Hb level was 10.9 g/dl, which decreased to 9.6 g/dl at the end of surgery. A total of 1,000 ml of isotonic balanced crystalloids were infused during surgery.

The preoperative NPRS score was 8, which decreased to 2 at the end of surgery. Postoperative pain was managed solely with acetaminophen, and no rescue therapy was needed. Rehabilitation was initiated on the first postoperative day, and the patient was discharged after 8 days with a good functional recovery.

Case Three

An 85-year-old female weighing 80 kg, 1.73 m of height, BMI 27 kg · m^{-2}, ASA status III patient was diagnosed with left neck femur fracture, and

she underwent intramedullary femur nailing with PFNA nail Synthes®. She had a medical history of 2:1 atrioventricular block treated with permanent pacemaker implantation, percutaneous coronary intervention in treatment with aspirin and clopidogrel, and hypercholesterolemia in treatment with statins.

Target RASS score during surgery was achieved with a dexmedetomidine infusion rate of 1.1 mcg/kg/h. Sufentanil 10 mcg was administered to reduce patient discomfort during the procedure, which lasted 75 minutes.

The intraoperative period was uneventful, without significant hemodynamic instability. Median blood pressure was 70 mmHg (IQR 67-75), and median heart rate was 70 bpm (IQR 58-73). A total 0.5 mg of atropine and 500 ml of 5% human serum albumin were administered. Preoperative Hb level was 14.5 g/dl and 11 g/dl at the end of surgery. Preoperative NPRS was 7, which decreased to 0 at the end of surgery. Postoperative pain was managed by acetaminophen; 100 mg of tramadol as rescue therapy was needed on postoperative day 1 after the first physiotherapy session. Length of stay was 17 days due to SARS-CoV2 asymptomatic infection.

Discussion

To the best of our knowledge, this is the first report demonstrating the anesthetic management of intramedullary femoral fixation in HF patients using a combination of PENG block and dexmedetomidine sedation.

HF surgery is commonly associated with moderate to severe postoperative pain, which often persists throughout the perioperative period[14,15]. Pain can increase the risk of perioperative complications, including delirium, pulmonary complications, cardiovascular events, and can hinder rehabilitation, leading to prolonged hospital stays[16-18]. Opioid analgesia, traditionally used in the frail elderly population, is known to be associated with various complications such as delirium, urinary retention, nausea, constipation, and respiratory depression[19-22]. As a result, opioid analgesics are now rarely prescribed, and multimodal approaches using different classes of analgesic adjuvants are recommended with a strong level of evidence in the last guidelines[15,17,18,23-27].

Although several peripheral nerve blocks and inter-fascial plane blocks have been suggested to reduce postoperative pain and opioid use in hip surgery, adequate pain control and relief after surgery for femur fracture is still challenging[28-34]. Furthermore, peripheral nerve blocks may induce weakness in the quadriceps muscles, leading to prolonged hospital stays and increased fall risk[34,35].

The complex sensory innervation of the anterior capsule of the hip joint makes it difficult to block with conventional techniques[36,37]. Classic techniques such as FN block, 3-in-1 block, and fascia iliaca block are unlikely to consistently block the articular branches from AON and FN, as indicated by anatomical studies[30-38]. In contrast, the PENG block specifically targets the articular branches of AON and FN to the hip joint between AIIS and IPE. Moreover, the PENG block has a motor-sparing effect compared to both the fascia iliaca block and the FN block, as it primarily blocks sensory branches[38,57].

In this case series, all patients achieved optimal postoperative pain control using the PENG block with a reduced amount of local anesthetic (20 ml) compared to the fascia iliaca block typically used by the authors. Additionally, the motor-sparing effect is particularly important in elderly patients with a high surgical risk, as it helps reduce the risk of accidental falls during the postoperative period.

The patients included in this case series were receiving antiplatelet therapy, and NA was contraindicated due to the potential complications of bleeding associated with both neuraxial and peripheral nerve blocks. The risk of bleeding is increased in patients on antiplatelet and anticoagulant drugs, and guidelines recommend specific time intervals before and after blockade to minimize the risk of antithrombotic drug-induced hematoma formation[13]. An individual risk-benefit analysis should always be performed in consultation with the patient before any regional anesthesia procedure. In cases where the risk of thromboembolism is high, it may be preferable to continue antithrombotic drugs perioperatively without withdrawal, and alternative techniques such as general anesthesia or low bleeding risk regional anesthesia techniques should be considered. In low-risk bleeding peripheral nerve blocks, the time intervals generally do not apply, but for deep peripheral nerve blocks (such as lumbar plexus block and paravertebral blocks), the same recommendations as neuraxial techniques should be followed[13]. While there is uncertainty whether the PENG block is considered a superficial or deep block, the cases described in this series were per-

formed before the release of the updated guidelines in June 2021[13]. However, we do not consider the PENG block to be a deep procedure. The injection target was usually no deeper than 4 cm, and a linear probe was used successfully in all patients in this case presentation. Furthermore, the anatomical planes crossed by the needle during PENG block do not contain vascular structures, with the femoral vessels being superficial and clearly visible away from the block target. Additionally, the PENG block is performed at the level of the inguinal crease, which is a compressible site. Lastly, the guidelines did not provide specific evidence of complications following PENG block execution[13,59]. Therefore, we consider the PENG block to be safer than a deep block or NA, even in patients on antithrombotic therapy.

However, caution with the application of this block has been claimed, given the proximity of the target area to the femoral artery. So far, no major complications such as hematoma/bleeding or needle-related organ injury have been reported[57].

On the other hand, there are some reports of FN and ON nerve block, that were either inadvertent or sought-after. Concerns regarding possible intravascular or blood collection catheterization have arisen for continuous PENG block.

The use of a peripheral nerve block as the sole anesthetic technique for hip surgery has not been extensively studied. Ahiskalioglu et al[41,42] described the use of a high-volume PENG block for surgical anesthesia in lower limb surgery, suggesting it as an alternative to lumbar plexus block. In a preliminary case series, Sandri et al[43] demonstrated that a PENG block combined with local infiltration anesthesia was an effective anesthesia technique for total hip arthroplasty with a direct anterior surgical approach. Another report[44] described PENG blocks used as surgical anesthetic techniques for hip arthroscopy in combination with lateral femoral cutaneous nerve block. There are also reports of PENG block being used as an analgesic technique for sickle cell disease vaso-occlusive crisis and PENG radiofrequency ablation for osteoarthritis analgesia[45,46]. Finally, another report investigated the use of a PENG block for leg vein ligation and stripping[47].

The use of sedation in patients undergoing hip surgery under regional anesthesia is essential for intraoperative comfort and safety. Common choices for sedation include benzodiazepines, propofol, and fentanyl[60-62]. However, these sedation agents can potentially cause respiratory depression, hemodynamic disturbances, agitation, and delirium, especially in elderly patients[60-63]. The adverse profile of benzodiazepines, propofol, and opioids, along with the surgical stress response, has created a need for a sedative drug that can be used safely during monitored anesthesia care (MAC) in high-risk patients with limited adverse effects. Dexmedetomidine is a centrally acting α-2 pre- and postsynaptic adrenergic receptor agonist that can be titrated to the desired level of sedation without significant respiratory depression[49-56]. Dexmedetomidine has an analgesic-sparing effect during and after surgery, a mild sympatholytic effect that can attenuate the stress response to surgery, and is increasingly being used as a sedative for MAC. Furthermore, dexmedetomidine has been associated with a reduction in delirium compared to other sedatives, particularly modulators of GABA-A receptors[51]. To prevent the sympatholytic action resulting in bradycardia and hypotension, initial boluses of dexmedetomidine are usually avoided[49-51]. Recent evidence[54] suggests that intravenous infusion of dexmedetomidine during hip fracture surgery can reduce intraoperative bleeding without causing hemodynamic disturbances. Considering all these factors, the use of dexmedetomidine for sedation in older patients undergoing regional anesthesia is recommended.

Limitations

We acknowledge that this study has some limitations. First, these pilot clinical results need to be confirmed by broad clinical studies. Second, this study was a single-center study. Third, the aim of the study was to evaluate the effects of a specific locoregional analgesia approach without analyzing the comparison with other analgesic techniques.

Conclusions

The PENG block can be successfully used as the sole anesthetic technique for elderly patients undergoing intramedullary femoral fixation while receiving antiplatelet drugs. This procedure effectively controls pain during both the surgical and postoperative periods. An adequate analgosedation must be warranted, and when combined with dexmedetomidine sedation, PENG block provides a good surgical outcome, minimizing the risk of perioperative neurocognitive dysfunctions and adverse effects on cardiorespiratory function.

However, further clinical trials are needed to investigate the efficacy and safety of the PENG block as the sole anesthetic technique for hip surgery.

Conflict of Interest
The Authors declare that they have no conflict of interest.

Ethics Approval
The Ethics Institutional Review Committee of Fondazione Policlinico Universitario A. Gemelli IRCCS approved the study (approval number ID 3993).

Informed Consent
All enrolled patients gave their written informed consent to participate, according to the Declaration of Helsinki.

Data Availability
The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

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Authors' Contributions
All authors contributed to data analysis, drafting, and revising the article, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

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