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# Peri-Capsular Nerve Group Blocks in the Emergency Department (ED) - A Broad Overview

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## Abstract

Hip fractures and related conditions present significant challenges in emergency departments (EDs, necessitating effective pain management for diagnostic evaluations and immediate interventions. The Pericapsular Nerve Group (PENG) block, a recent innovation in regional anesthesia, has gained prominence for its profound impact on pain control in hip fractures. This article comprehensively reviews the evolution, anatomy, and applications of PENG blocks in emergency medicine.

PENG blocks offer precise, sensory-focused pain relief, crucial for patients experiencing severe acute pain due to hip fractures. By comprehensively targeting articular branches of the femoral, obturator, and accessory obturator nerves with a single injection, PENG blocks preserve motor function and reduce reliance on systemic opioids, leading to more comfortable reductions of hip dislocations and improved patient experiences.

The PENG block emerges as a valuable asset in revolutionizing pain management for hip fractures within emergency departments, aligning with the overarching goal of enhancing patient care and well-being. As healthcare confronts the challenges of patient comfort and the opioid crisis, further research, including Randomized Controlled Trials and comprehensive Meta-analyses, is warranted to establish definitive recommendations for ED practices in this domain.

**Keywords:** PENG Block; Pericapsular Nerve Group Block; Emergency Department

## Significance of Peri-Capsular Nerve Group Blocks in ED Pain Management

The pericapsular Nerve Group (PENG) block is a relatively recent advancement in regional anesthesia, gaining significant recognition for its profound impact on the management of hip fractures and related conditions [1].

Its significance in the emergency department(ED) lies in its ability to offer targeted sensory-only pain relief, especially in the context of hip fractures where acute pain can be excruciating [2].

Hip fractures are frequently encountered in the Emergency Department, often necessitating immediate

pain management to facilitate diagnostic evaluations and interventions. The PENG block, when integrated into a multimodal anesthesia approach, plays a pivotal role in enhancing patient care [3].

PENG block provides more effective analgesia and protects motor functions by blocking the articular branches of the femoral, obturator, and accessory obturator nerves in the hip with a single injection. Studies have also shown that PENG block has been successfully used as a popular regional anesthesia technique for the management of acute pain in hip pathologies without causing quadriceps weakness [1].
By delivering precise analgesia to the nerves innervating the hip joint, it not only reduces pain effectively but also minimizes the reliance on systemic opioids, thereby reducing the risk of opioid-related complications [4].

This approach contributes to safer and more comfortable reductions of hip dislocations, hip and femur fracture management along with improved patient experiences, and the potential for better functional outcomes. In an era where improving patient comfort and combating the opioid crisis is paramount, the PENG block emerges as a valuable tool in optimizing pain management for hip fractures within the ED, aligning with the overarching goal of enhancing patient well-being and care quality.

## Anatomy and Physiology of Pericapsular Nerve Groups

The hip joint is supplied by the femoral obturator, accessory obturator, sciatic, and superior gluteal nerves [5]. The femoral nerve, arising from the lumbar plexus through the ventral rami of spinal nerves L2-L4, originates at the lateral edge of the psoas muscle. It then courses between the iliacus and psoas muscles before bifurcating into its primary divisions: anterior and posterior branches. These branches serve distinct functions, with the anterior branch providing motor innervation to the hip flexor muscles and knee extensors, while also supplying sensory innervation to the anteromedial region of the thigh. In addition, the femoral nerve issues a motor branch to the iliac muscle before passing beneath the inguinal ligament.

The articular branches at the hip joint indeed have an interesting distribution pattern [6]. They often originate at a higher level along the course of the femoral nerve. This anatomical arrangement can explain why certain nerve blocks, such as the femoral block or the fascia iliaca compartment block, may not always provide complete or sufficient analgesia for hip-related pain.

The obturator nerve originates from the lumbar plexus, specifically the anterior divisions of spinal nerves L2, L3, and L4. It courses through the fibers of the psoas major muscle, descending posteriorly to the common iliac arteries. As it progresses, it runs laterally along the pelvic wall before ultimately dividing into two branches within the obturator canal: the anterior and posterior branches. The anterior branch subsequently perforates the fascia lata, transitioning into the cutaneous branch of the obturator nerve. This cutaneous branch is responsible for supplying sensory innervation to the skin of the middle portion of the medial thigh [6]. The accessory obturator nerve is a relatively rare anatomical variation found in approximately 10% to 30% of individuals. It typically arises from the third and fourth lumbar nerves, which are derived from the ventral rami of spinal nerves L2 to L4. The primary areas it often innervates include the hip joint and the adductor longus muscle. Notably, research has indicated that the accessory obturator nerve plays a role in providing sensory innervation to the medial capsule of the hip joint. This innervation includes sensory fibers, which contribute to the sensory perception of this region. Short, et al. [7] segmented the hip capsule into anterior and posterior sections, revealing that nociceptive fibers are concentrated mainly in the anterior part. In contrast, the posterior capsule primarily houses mechanoreceptors, specialized for detecting mechanical stimuli, and contributing to proprioception and joint stability rather than pain perception. The anterior region of the hip capsule receives its primary sensory innervation from high branches of both the femoral and obturator nerves, including the accessory obturator nerve. This study also put in evidence important landmarks for those articular branches. The high articular branches from FN and AON are consistently found between the anterior inferior iliac spine (AIIS) and the iliopubic eminence (IPE), whereas the ON is located close to the infero-medial acetabulum [8].

The anatomical course within the psoas major muscle and the proximity of the articular branches from these three nerves to the inferomedial acetabulum, as well as the space between the anterior inferior iliac spine and iliopubic eminence, suggest promising locations for regional analgesia. This implies that the strategic administration of local anesthetics within the fascial plane between the psoas muscle and the upper pubic branch can effectively anesthetize these three nerves, consequently providing comprehensive coverage for hip anesthesia [9]. There may be additional osseous sensory anesthesia by local anesthetic spread along the bone surface, and possibly even hematoma block at the fracture site [10]. This may be particularly true for acetabular fractures given the injection site are adjacent to the acetabulum.

This insight into the distribution of sensory fibers and identification of promising location for regional anaesthesia underscores the necessity for precise techniques, like the

peri-capsular nerve group (PENG) block, to effectively target the anterior hip capsule and alleviate pain for patients experiencing discomfort in this area.

## Historical Context

The PENG block was developed based on anatomical studies by Giron Arango, et al. [1] on hip innervation which led to the identification of relevant landmarks to target the hip articular branches of femoral nerve and accessory obturator nerve [1].

Over time, a growing number of case reports have emerged, documenting the effectiveness of the Pericapsular Nerve Group (PENG) block for anesthesia. These reports have not only highlighted its efficacy but have also demonstrated its successful application in the Emergency Department (ED) [11].

The utilization of the PENG block has evolved beyond its initial role as an adjunctive block for hip surgeries and post-operative anesthesia. It has transitioned into what is known as an 'on-arrival-block,' which involves administering the block when positioning the patient for spinal or epidural anesthesia. This concept of providing the block upon the patient's arrival had allowed its extension into the realm of the Emergency Department (ED), where its application has become increasingly common.

## Evolution of Pericapsular Nerve Group Blocks in Emergency Medicine

Pelvic fractures are a common and painful presentation in emergency departments. In fact, nearly 8% of ground-level falls in patients aged over 70 years lead to pelvic fractures, which are associated with significant morbidity and mortality, resulting in a nearly 2.4-fold increase in the risk of death [12]. On the other end of the age spectrum, younger adults involved in traffic accidents contribute to the opposite peak of this bimodal age distribution for pelvic fractures [13]. Similar to hip fractures, effective pain control is essential in promoting early mobilization and is a critical component of managing stable pelvic fractures in the acute setting. Ideally, this involves the use of multimodal analgesia, which can reduce morbidity and shorten hospital stays. However the challenge arises when considering existing regional anesthesia techniques for pelvic fractures. Techniques like lumbar plexus blocks, while effective, are difficult to perform, require repositioning of injured patients from the supine position, carry the risk of epidural spread, and are not readily available in the Emergency Department (ED). Consequently, this leaves emergency medicine without a clear and accessible pathway for regional anesthesia in cases of pelvic fractures [14].

It is in the background that PENG blocks were explored in the emergency department. A feasibility study by Ramachandran, et al. [15] showed that PENG blocks were safely administered by trained emergency physicians and further demonstrated a trend of pain relief and decreased opiate requirements [15]. It has been demonstrated that the PENG block can be provided safely and effectively to patients with hip fracture in the ED. The PENG block can be safely and effective performed by emergency physicians, even by a group of providers relatively inexperienced in the technique. There was no difference observed in maximal pain score reduction within 60 min for the PENG block compared to FB. Additionally more patients were opioid-free after a PENG block, although no significant difference in median opioid use was detected [16].

A randomised control trial by Marrone, et al. [17] showed non-inferiority of PENG block as compared to Fascia iliac block in elderly patients with proximal femur fractures [17]. In support, several other studies have unequivocally stated that the pericapsular nerve group block is feasible in the emergency department and has the potential to provide excellent pain relief and decrease the amount of opioid use during the preoperative phase in emergency department patient with hip fractures [14-18].

## Techniques for Pericapsular Nerve Group Block

To perform the PENG block (In-plane), follow these steps with the patient in the supine position [14]:

- Elevate the bed and arrange the ultrasound system to ensure a clear line of sight for the needle, transducer, and ultrasound screen with minimal head movement.
- Position a low-frequency curvilinear transducer on the proximal thigh, rotated about 45 degrees from the transverse orientation. Place it roughly parallel to and next to the inguinal crease. For patients with low body mass, a high frequency linear transducer may be used [19].
- Begin by identifying the femoral artery and the femoral head using ultrasound imaging.
- While keeping the femoral artery in view, slide the transducer upwards to visualize the ilium. Look for landmarks such as the anterior inferior iliac spine and iliopubic eminence.
- The target for injection lies on the bone surface of the ilium, just lateral to the psoas tendon, which is positioned between the anterior inferior iliac spine and the iliopubic eminence.
- Identify a suitable needle insertion site that aligns with the long axis of the ultrasound beam. This site should be lateral to the transducer, about 1–2 cm away from it.
- After ensuring sterility, create a local anesthetic (LA)

skin wheal at the chosen insertion site using a 25–27 G needle.

- Insert a block needle, such as a Quincke 20 G 3.5-inch (90-mm) lumbar puncture needle, through the skin wheal. Advance the needle at an angle of 30–45 degrees toward the ultrasound beam.
- Continue advancing the needle with in-plane ultrasound guidance through the iliopsoas toward the target site. Ensure that the needle remains deep and just lateral to the psoas tendon.
- Aim for a firm bony endpoint by contacting the surface of the ilium with the needle tip
- Perform alternate aspirations to confirm the absence of inadvertent vascular puncture, and then inject small aliquots of normal saline (NS) to ensure proper needle placement.
- As a sign of successful injection, observe anechoic fluid spreading adjacent to the bone, deep to the psoas fascia. This fluid should elevate the iliopsoas muscle and the psoas tendon with each injection.
- Once you are satisfied with the spread of fluid, switch from NS to the local anesthetic. Gradually inject small aliquots until you reach the desired total volume. 20mL is generally sufficient in most patients.
- Typically, the entire needling process takes less than 5 minutes, and analgesia develops within about 30 minutes.

## Drug Dosage

There is no recommendation regarding the optimal dose of local anesthetic for use in PENG block. Case reports and series have commonly used a volume of 20mL 0.25% bupivacaine as local anesthetic for PENG block [20]. Giron-Arango, et al. [1] stated that using more than 20 ml for FNB may cause undesirable motor blocks. In the cadaver study of Ciftci, et al. [21] 30 ml and 20 ml dye was used and they detected dye diffusion around the femoral nerve, femoral cutaneous nerve, and obturator nerve trace from inguinal to knee in the 30 ml group [21]. Thus, they reported that this could explain the motor weakness in patients after high-volume anesthetic substance use. In accordance with the literature, we typically also use 20 ml of 0.25% bupivacaine for PENG block in our ED and no major complications have developed in any of our patients till date.

## Complications and Effectiveness

PENG block appears to be a safe procedure with no major complications reported by most studies [15,22,23]. Certain case reports and reviews demonstrate quadriceps muscle weakness, especially following large volume infiltration [22,24]. Ahiskalioglu, et al. [25] reported motor weakness in patients of high volume PENG block application. The rates of these complications appear low. Yu, et al. [26] administered PENG block for analgesia to more than 100 HF patients with the same volume (20 ml). Quadriceps weakness developed in only two patients and resolved in 2 days.

A double blind prospective RCT [27] has shown that VAS score significantly reduced in the PENG block group (after 15minutes of blocks and after 12hours of post-surgery) compared with the FICB group (p=0.031; p=0.021, respectively). The first time of the analgesic consumption after surgery was significantly longer in the PENG block compared with the FCIB (p=0.007). Compared with the FICB group, the total dose of morphine consumption during 24hours significantly reduced in the PENG block (p=0.008).

In a propensity matched cohort study, following block, patients receiving PENG (median 4, IQR: 26) had a similar pain score (p - 0.55) to that in the FICB arm (median 4, IQR: 1-5). The 60-minute pain scores were similar (p - 0.14) in both arms (PENG: 1, 0-2; versus FICB: 1, 1-2). The attached figure shows the median and IQR pain scores. Total oral morphine milligram equivalents used 12 hours post-block in the PENG arm was 41 mg (IQR: 29-63), which was similar to that in the FICB arm (median: 49mg, IQR: 3258.5) (p - 0.34) [28].

## Technical Considerations

- Quadriceps weakness may occur post-PENG block, but it doesn't necessarily affect the straight leg raise (SLR) test since the SLR mainly involves hip flexors, not quadriceps [26]. Patients may also resist leg movement due to fear of pain.
- To identify the target injection site for PENG blocks more efficiently, scan distally to visualize the acetabulum/femoral head's curved contour and then return proximally to view the linear contour of the iliopubic eminence, especially helpful in obese patients [29].
- When dealing with well-built and thin individuals, consider using a linear probe for optimal visualization.
- In some cases, a steep needle insertion angle may be necessary, which could hinder proper visualization, so use of echogenic needles is advisable.
- Be cautious about a more medial needle placement, which may pose a risk of ureter injury [19].
- To minimize the risk of bladder injury, gather information about the patient's last urination and perform a negative aspiration test for urine before the procedure [30].
- Avoid using large volumes of local anesthetic to prevent motor blockade [22,23].
- Apply local anesthetic at the needle insertion site to monitor for paresthesia, and consider using an out-of-plane (OUT) approach to reduce the likelihood of inadvertent injury to the lateral femoral cutaneous nerve

(LFCN) [31,32].

## Summary of Key Findings and Insights

- PENG Block's Significance: The Pericapsular Nerve Group (PENG) block has emerged as a valuable tool in pain management for hip fractures in the Emergency Department (ED) due to its ability to provide targeted sensory-only pain relief, enhancing patient care.
- PENG Block Anatomy: The PENG block effectively provides analgesia for hip fractures by blocking articular branches of the femoral, obturator, and accessory obturator nerves with a single injection.
- Multimodal Analgesia: Effective pain control, including multimodal analgesia, is crucial for early mobilization and acute management of stable pelvic and hip fractures.
- Challenges with Existing Techniques: Existing regional anesthesia techniques like lumbar plexus blocks are challenging to perform in the ED, often requiring repositioning and carrying the risk of epidural spread.
- Reduced Opioid Dependence: PENG block minimizes reliance on systemic opioids, contributing to safer reductions of hip dislocations and improved patient experiences.
- Application in ED: Feasibility studies and trials have shown that PENG blocks can be safely and effectively administered by emergency physicians in the ED, providing pain relief and reducing opioid use.
- Technical Considerations: Precise identification of injection sites and landmarks is crucial for successful PENG block administration, and avoiding complications (see technical considerations).
- Comparative Studies: Comparative studies have shown non-inferiority of PENG blocks compared to other techniques like the Fascia Iliaca Compartment Block (FICB) and Femoral nerve block for pain control in hip fractures.
- Dosage and Complications: Most studies have advocated 20-30 mL of 0.25-0.5 % bupivacaine [22-26]. Complications, such as quadriceps weakness, have been observed with higher volumes. Rarer but significant complications include vascular puncture, urethral or bladder injury and LCFN Injury.
- Enhanced Recovery: PENG blocks can contribute to enhanced recovery protocols in hip surgery, although full weight bearing on the operated leg may not always be required.

Pericapsular nerve group blocks have emerged as a valuable tool in ED pain management for hip-related conditions. However, further investigation is warranted to comprehensively assess adverse effects, duration of hospitalization, and additional related outcomes. To establish definitive recommendations for ED practices, there is a pressing need for an increased number of Randomized Controlled Trials (RCTs) and comprehensive Meta-analyses in this domain.

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