

Pericapsular Nerve Group Block: An Evidence-Based Discussion

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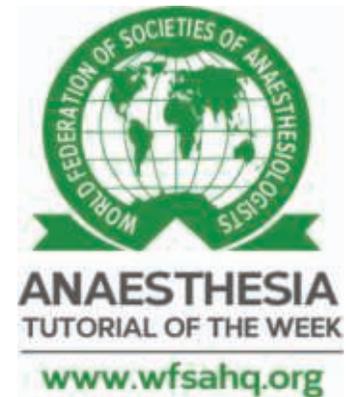
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KEY POINTS

- Pericapsular nerve (PENG) block is a novel regional anaesthesia technique that has been suggested as an alternative to existing blocks to reduce pain following hip fractures and hip surgery.
- It involves blocking, with 1 ultrasound-guided injection, the articular branches of the femoral nerve, the obturator nerve and, where present, the accessory obturator nerve to the hip.
- Case series have suggested that PENG block has the potential to provide comparable or greater analgesic benefit than existing techniques, such as femoral nerve or fascia iliaca blocks.
- PENG block is a motor-sparing block, targeting only the sensory innervation of the hip, potentially allowing for earlier mobilisation and recovery postoperatively.

INTRODUCTION

Hip fracture is the most common serious injury in the elderly population and is also the most common cause of emergency surgery in older people. Age-standardised annual rates of hip fracture range from 260 to 349/100 000 in women and 122 to 140/100 000 in men in the United States and the United Kingdom, respectively.¹ Surgical reduction and fixation is the definitive treatment in most cases.² Meanwhile, total hip arthroplasty is the international standard of care for degenerative hip joint disease. The average rate of total hip replacement among the 38 countries of the Organisation for Economic Co-operation and Development is 182 procedures per 100 000 members of the population.³

There are a number of regional analgesia techniques to alleviate pain after hip fracture and hip arthroplasty surgery, although many may have undesirable side effects. Regional techniques, including femoral nerve (FN) block, fascia iliaca compartment block (FICB) and femoral 3-in-1 block, are used regularly due to their ability to reduce postoperative pain as well as reduce opioid consumption and related adverse effects of opioids.² However, recent anatomical studies have shown that the articular branches of both the femoral and obturator nerve, those that innervate the anterior hip capsule, may not be optimally blocked by these techniques.⁴ These blocks also generally cause a degree of motor blockade that can delay postoperative mobilisation.

The pericapsular nerve group (PENG) block is a novel regional anaesthesia technique, first described in 2018, which can be used as an alternative to FN block or FICB to reduce pain postoperatively after hip surgeries. It targets, with 1 injection, the

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nerves supplying the anterior capsule of the hip, namely, the obturator nerve, the accessory obturator nerve (where present) and the articular branches of the FN.

Although still in its infancy, multiple case reports have shown the potential of the PENG block to successfully reduce postoperative pain following hip surgery as well as reduce opioid consumption and minimise opioid-induced side effects, essential in this elderly patient cohort. It has also been found to be a motor-sparing block, with the potential of enabling earlier postoperative mobilisation for patients.²

This tutorial will examine the literature available on the clinical application of the PENG block. We will discuss the anatomical basis for the block's success and describe the technique itself, before looking ahead to examine what the future may hold for the PENG block.

WHAT IS THE PENG BLOCK?

The PENG block is a regional analgesia technique, first described in 2018 by Girón-Arango et al² as a novel approach to reducing postoperative pain and opioid consumption in patients following hip fracture surgery. It is a plane block involving 1 injection, performed under ultrasound guidance, of a high volume of local anaesthetic into the musculofascial plane between the psoas tendon anteriorly and the pubic ramus posteriorly² (see Figure 1).

This first study by Girón-Arango et al² described the technique and its successful application in 5 patients with hip fracture. The PENG block showed a clinically relevant reduction in pain scores, comparable to alternative regional techniques. The technique was also found to have a potential motor-sparing effect when compared with the FN block and FICB, with no quadriceps weakness reported in any of the 5 patients postoperatively.²

ANATOMICAL BASIS FOR THE PENG BLOCK'S SUCCESS

One of the principal challenges of effective regional analgesia for hip pain is the complex innervation of the hip joint by multiple nerves. Recent anatomical studies of the hip joint have clarified this anatomy. The anterior hip capsule has been shown to be supplied by articular branches of the femoral, obturator and accessory obturator nerves, where present.⁴ The posterior capsule is innervated most commonly by the nerve to the quadratus femoris, while small articular branches from the sciatic nerve and superior gluteal nerves may also be seen.⁵ The anterior capsule, which contains most of the sensory innervation of the joint and has been identified as the main source of the majority of postoperative hip pain, is the target of the PENG block.^{3,4}

Short et al⁴ further demonstrated that 'high' sensory articular branches of the FN, originating cranially to the inguinal ligament, play a greater role in the innervation of the anterior hip capsule than previously thought. These articular branches enter the iliacus muscle at the L4-L5 level, travel deep to the psoas muscle between the anterior inferior iliac spine and iliopubic eminence, before innervating the hip capsule.⁴ The accessory obturator nerve is present in 10% to 30% of cases. It courses deep to the psoas muscle from the L5 level before innervating the medial aspect of the hip joint capsule.⁴

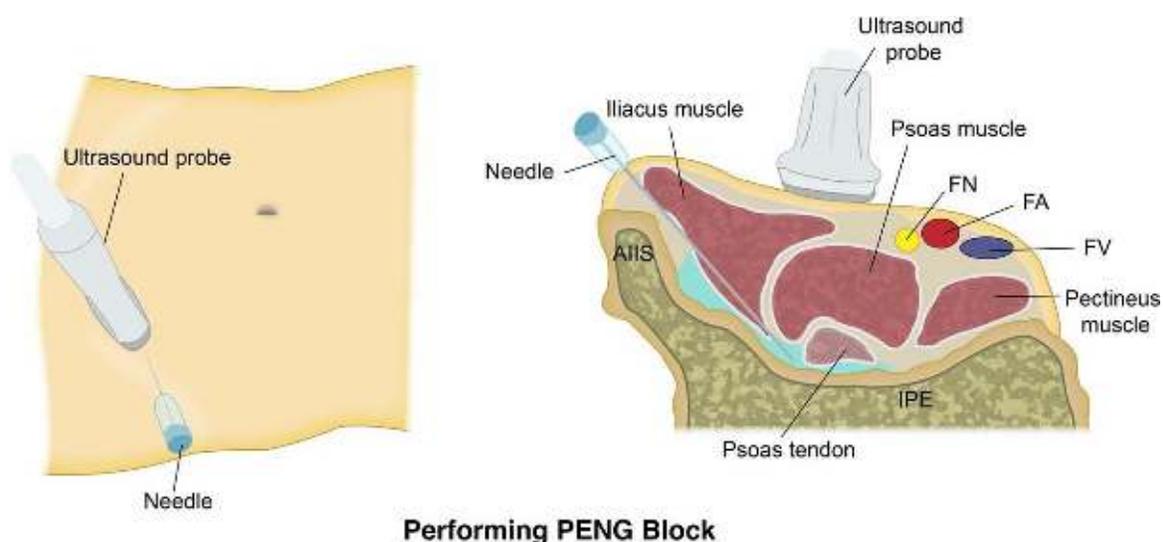


Figure 1. Diagrammatic representation of performance of the pericapsular nerve group block. AIIS, anterior inferior iliac spine; IPE, iliopubic eminence; FN, femoral nerve; FA, femoral artery; FV, femoral vein.

The spread of local anaesthetic after infrainguinal regional analgesia techniques targeting the hip capsule, such as infrainguinal FICB and femoral 3-in-1 block, have been studied in separate studies using magnetic resonance. It has been shown that the cephalad spread of local anaesthetic after these blocks is unlikely to extend above L5.⁶ Therefore, neither the infrainguinal FICB nor the femoral 3-in-1 block are likely to consistently block the articular branches of the FN or the accessory obturator nerve. Further studies have also shown that these regional techniques also frequently fail to adequately block the obturator nerve.⁷ These anatomical findings explain why it is difficult to achieve optimum analgesia for the hip joint using infrainguinal regional techniques such as the FN block, FICB or femoral 3-in-1 block. More recently, a suprainguinal approach to the FICB has been proposed and was shown to provide a more consistent spread of local anaesthetic in a cranial direction under the fascia iliaca. This suprainguinal FICB provided a more reliable spread to the anatomical location of the 3 target nerves on magnetic resonance imaging than an infrainguinal approach.⁸

The PENG block is also a suprainguinal approach to targeting pain arising from the hip capsule. The high articular branches of the FN and the accessory obturator nerve have been consistently found between the anterior inferior iliac spine and the iliopubic eminence, while the obturator nerve runs close by, in close proximity to the inferomedial acetabulum.⁷ Using these anatomical details, the PENG block can be applied to block all 3 nerves that innervate the anterior capsule of the hip with 1 injection of local anaesthetic.

MECHANISM OF ACTION

The PENG block is an interfascial plane block, targeting the plane between the psoas tendon anteriorly and the pubic ramus posteriorly. Deep fascial planes are potential spaces and can act as 'transmission belts' for the spread of local anaesthetic within the body. The efficacy of interfascial plane blocks relies on the local anaesthetic agent passively distributing with the plane to reach the target nerves. To date, there has been 1 study investigating the spread of local anaesthetic following PENG block.⁹ Tran et al⁹ performed the PENG block in a cadaveric specimen, injecting methylene blue and observing the staining pattern within the hip joint. The dye spread in the bursal space between the iliopsoas and anterior hip joint and stained the entire anterior hip joint capsule. Although further research is required to verify these results and determine the optimal volume of local anaesthetic for the block, this study provides support that the block successfully captures the articular branches of the femoral, obturator and accessory obturator nerves, as originally described.⁹

One limitation of the PENG block is that the lateral femoral cutaneous nerve (LFCN) is not routinely blocked by the technique. Due to skin incision and subcutaneous dissection, postoperative pain after posterior and direct lateral approach hip surgery will usually include dermatomal pain for the lateral thigh supplied by the LFCN. A combination of PENG block with LFCN block (or incision site infiltration with local anaesthetic) may provide better analgesia than PENG block alone for this reason.¹⁰

TECHNICAL PERFORMANCE OF THE PENG BLOCK

The PENG block is performed with the patient in the supine position and the operator standing on the ipsilateral side of the affected limb. The ultrasound machine should be positioned with the screen in a direct line of sight. A low-frequency (curvilinear) ultrasound probe (2-5 MHz) is initially placed in a transverse plane over the anterior inferior iliac spine, before being aligned with the pubic ramus by rotating the probe 45° counterclockwise (see Figure 1). It should be possible to observe the iliopubic eminence, iliopsoas muscle tendon, femoral artery and pectineus muscle in this view. The FN should be identified during scanning prior to needle insertion. An 80-mm sonographic needle should be inserted from lateral to medial in an in-plane approach, with the aim of placing the tip in the musculofascial plane between the psoas tendon anteriorly and the pubic ramus posteriorly (see Figures 2 and 3). Negative aspiration should be observed before injection of local anaesthetic into the plane and observation of fluid spread in the desired plane.²

There are no studies published to date examining the effect of varying the specific local anaesthetic used or the volume used. In their original case series, Girón-Arango et al² performed most of their PENG blocks with 20 mL of 0.25% bupivacaine and epinephrine 1:400 000. In general, a high volume of local anaesthetic has been used in most published case reports and case series describing PENG blocks, with 20 to 30 mL of 0.25% to 0.5% bupivacaine or levobupivacaine commonly used, with or without epinephrine. Dexamethasone has been used as an additive by some authors to extend the duration of the block.¹¹

PENG BLOCK IN THE LITERATURE

Since the first publication in *Regional Anaesthesia and Acute Pain* in late 2018 of the paper by Girón-Arango et al,² the PENG block has generated a wide level of interest. Because of the relative infancy of the PENG block, the available literature on the technique is largely limited to case reports and cohort studies, with a scarcity of randomised controlled trials completed on the efficacy of the procedure to date. A wide range of published case studies indicate the potential of the PENG block to significantly improve hip joint analgesia, however, and multiple larger clinical trials investigating the technique are currently ongoing.

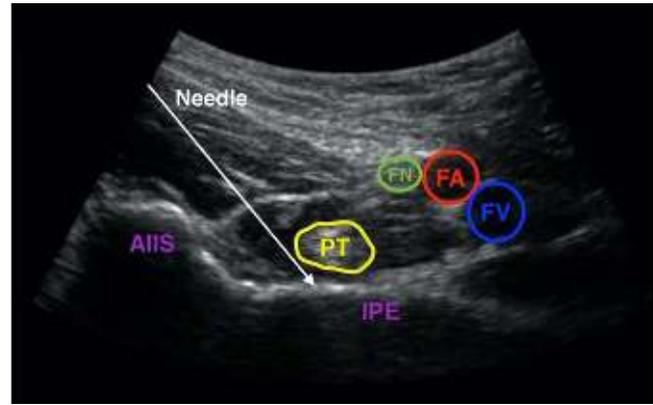
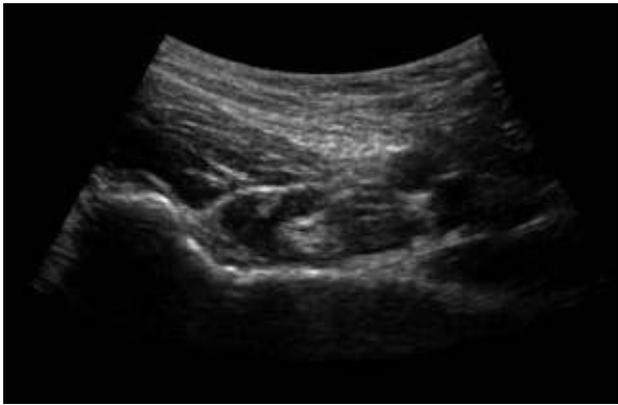


Figure 2. (Left) Sonographic anatomy of the pericapsular nerve group block.

Figure 3. (Right) Same image as in Figure 2, labelled and with intended needle course. AIIS, anterior inferior iliac spine; PT, psoas tendon; IPE, iliopectineal eminence; FN, femoral nerve; FA, femoral artery; FV, femoral vein.

SUCCESSFUL ANALGESIC OUTCOMES

The PENG block has many potential advantages over traditional regional analgesia techniques used for pain originating in the hip capsule. Principally, the block has the potential to achieve a wider coverage of sensory nerves innervating the hip, improving analgesia and reducing postoperative pain. This may lead to reduced postoperative opioid consumption, resulting in fewer opioid-related side effects and less long-term opioid dependency.¹¹

As expected, most of the available literature regarding the PENG block involves its use in hip fracture patients or those undergoing hip surgery. A 2020 review of the available literature on PENG blocks performed for hip fractures and hip surgeries highlighted 20 case reports and case series, encompassing a combined total of 74 patients. In all 20 studies, the PENG block was shown to provide sufficient analgesia or anaesthesia.¹¹ In the first study by Girón-Arango et al, PENG block in patients with hip fractures reduced pain scores by a median of 7 points on a 10-point numerical rating scale.² A recent single-centre randomised control trial comparing PENG block to no block in patients undergoing total hip arthroplasty also showed that pain scores of patients who received PENG block were significantly reduced when compared with patients in the no-block group. The PENG block patients also showed a significant reduction in opioid consumption, better range of hip motion and shorter time to ambulation after surgery.¹²

OTHER BENEFITS

The PENG block targets only the sensory innervation of the hip, and case studies have reported a potential motor-sparing effect when compared with the FN block and FI block.² In a larger, randomised comparison between PENG block and suprainguinal fascia iliaca block for patients undergoing primary total hip arthroplasty, PENG block resulted in a lower incidence of quadriceps motor block and an increased preservation of hip adduction than suprainguinal fascia iliaca block did, with no significant difference between the groups in postoperative pain scores, opioid consumption or length of hospital stay.¹³ The absence of motor blockade after PENG block may allow earlier patient mobilisation postoperatively and earlier participation in rehabilitation, contributing to an early recovery.¹¹ Motor-sparing lower-limb blocks can also lead to a reduction in postoperative falls risk when compared with non-motor-sparing alternatives, although it must be noted that quadriceps weakness can still occur if inadvertent FN block or FICB occurs following PENG block (see the 'Adverse Effects and Risks' section). Further investigation is required to ascertain the optimum local anaesthetic volume to reliably provide motor-sparing PENG block, while research comparing PENG block with other motor-sparing strategies such as periarticular local anaesthetic infiltration would also be helpful.¹³

The easily identifiable sonographic structures involved in PENG block, including the anterior inferior iliac spine, the iliopubic eminence and the psoas tendon, make the technical performance of the block comparable to existing nerve blocks in terms of difficulty. This is supported by a lack of any serious adverse events after PENG block such as permanent nerve injury, vascular damage or local anaesthetic systemic toxicity reported in the literature to date, although it must be considered that the current literature is as yet too limited to make definitive assumptions regarding the safety of the technique.

ADVERSE EFFECTS AND RISKS

To date, 2 cases of motor weakness of the quadriceps following PENG block have been reported.¹⁴ In each case, the block was performed postoperatively and was reported to be technically challenging. The weakness was transient in both cases and has

been attributed to inadvertent FN or fascia iliaca blockade. Yu et al¹⁴ hypothesised that injection of local anaesthetic more superficially than intended, or needle placement medial to rather than posterior to the psoas tendon, may result in superficial spread of a proportion of the local anaesthetic and cause inadvertent FN or FI block. They also cautioned that postoperative performance of the block may allow spread of the local anaesthetic to unanticipated locations due to normal tissue planes being disrupted by surgery.¹⁴

When performing the PENG block, there is potential for the needle path to traverse both the FN or the LFCN of the thigh. It is vital to identify the FN in the scanning phase of the block, prior to needle insertion, to minimise the risk of injury. The LFCN has a smaller calibre and follows a more variable course as it passes into the anterior thigh below the inguinal ligament, making it more challenging to locate on ultrasound.¹⁰ Any complaints of lateral thigh pain after needle insertion require a prompt reassessment of the anatomy. The pelvic part of the ureter must also be considered. It lies on the pelvic wall in close proximity to the obturator nerve, where it has the potential to be injured by a more medial needle advancement or a medial to lateral needling technique.¹⁵ Despite these concerns, no injuries to the FN, LFCN or ureter have been described following PENG block in the literature to date.

LIMITATIONS OF THE LITERATURE

The PENG block remains in its infancy, with most data in the literature arising from case reports or case series. There are limitations inherent to these types of study, including publication bias and danger of overinterpretation. There is also no consensus on optimum injectate and volume, making comparisons between studies difficult.

A number of larger trials regarding the efficacy of the PENG block are ongoing as per the US National Library of Medicine's clinicaltrials.gov, although these are unpublished works at the time of writing. Ongoing research of interest includes randomised trials comparing PENG block to no block for primary hip arthroplasty, PENG block versus wound infiltration for hip replacement and PENG block versus FICB block in hip fracture patients. Studies comparing the efficacy of PENG block after different types of hip surgery (hemiarthroplasty vs Dynamic hip screw (DHS), for example) and after procedures involving different surgical approaches to the hip (anterior vs posterior) may be areas of interest in the future. Anatomic studies may also be useful to confirm the extent and reliability of the spread of local anaesthetic to the targeted nerves, as may a large cohort study to definitively investigate the safety of the technique.

SUMMARY

The PENG block is a novel regional anaesthesia technique that can be viewed as an alternative to FN block or FICB in the treatment of pain originating from the hip. Although the literature published to date is largely limited to case reports and case series, it has been shown to have the potential to provide greater analgesic benefit than existing regional analgesia techniques for patients with hip fractures or undergoing hip surgery. There has been no major adverse events reported arising from the technique, while it also has the potential to spare the motor innervation of the lower limb. Larger studies are required to determine its true efficacy when compared with other regional techniques, its safety and the optimum injectate volume.

REFERENCES

1. Kanis JA, Oden A, McCloskey EV, Johansson H, Wahl DA, Cooper C. A systematic review of hip fracture incidence and probability of fracture worldwide. *Osteoporosis Int.* 2012;23(9):2239-2256.
2. Girón-Arango L, Peng PW, Chin KJ, Brull R, Perlas A. Pericapsular nerve group (PENG) block for hip fracture. *Reg Anesth Pain Med.* 2018;43(8):859-863.
3. McPherson K, Gon G, Scott M. *International Variations in a Selected Number of Surgical Procedures.* OECD Health Working Papers. No. 61. 2013.
4. Short AJ, Barnett JJ, Gofeld M, et al. Anatomic study of innervation of the anterior hip capsule: implication for image-guided intervention. *Reg Anesth Pain Med.* 2018;43(2):186-192.
5. Nagpal AS, Brennick C, Occhialini AP, et al. Innervation of the posterior hip capsule: a cadaveric study. *Pain Med.* 2021;22(5):1072-1079.
6. Marhofer P, Našel C, Sitzwohl C, Kapral S. Magnetic resonance imaging of the distribution of local anesthetic during the three-in-one block. *Anesth Analg.* 2000;90(1):119-124.
7. Swenson JD, Davis JJ, Stream JO, Crim JR, Burks RT, Greis PE. Local anesthetic injection deep to the fascia iliaca at the level of the inguinal ligament: the pattern of distribution and effects on the obturator nerve. *J Clin Anesth.* 2015;27(8):652-657.

8. Vermeulen K, Desmet M, Leunen I, et al. Supra-inguinal injection for fascia iliaca compartment block results in more consistent spread towards the lumbar plexus than an infra-inguinal injection: a volunteer study. *Reg Anesth Pain Med.* 2019;44(4):483-491.
9. Tran J, Agur A, Peng P. Is pericapsular nerve group (PENG) block a true pericapsular block?. *Reg Anesth Pain Med.* 2019;44(2):257.
10. Roy R, Agarwal G, Pradhan C, Kuanar, D. Total postoperative analgesia for hip surgeries, PENG block with LFCN block. *Reg Anesth Pain Med.* 2019;rapm-2019-100454.
11. 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. *Reg Anesth Pain Med.* 2021;46(2):169-175.
12. Pascarella G, Costa F, Del Buono R, et al. Impact of the pericapsular nerve group (PENG) block on postoperative analgesia and functional recovery following total hip arthroplasty: a randomised, observer-masked, controlled trial. *Anaesthesia.* 2021;76:1492-1498.
13. Aliste J, Layera S, Bravo D, et al. Randomized comparison between pericapsular nerve group (PENG) block and suprainguinal fascia iliaca block for total hip arthroplasty. *Reg Anesth Pain Med.* 2021;46(10):874-878.
14. Yu HC, Moser JJ, Chu AY, Montgomery SH, Brown N, Endersby RV. Inadvertent quadriceps weakness following the pericapsular nerve group (PENG) block. *Reg Anesth Pain Med.* 2019;44(5):611-613.
15. Mistry T, Sonawane KB, Kuppusamy E. PENG block: points to ponder. *Reg Anesth & Pain Med.* 2019;44(3):423-424.



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