PROVA SCRITTA N. 1

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REVIEW

Pericapsular nerve group block: an overview

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ABSTRACT

INTRODUCTION: The PENG block is a recently described ultrasound-guided technique for the blockade of the sensory nerve branches to the anterior hip joint capsule. It was described as an analgesic block for the acute pain management after hip fracture, while subsequent studies expanded the original indication. The aim of this narrative review was to summarize the existing knowledge about the PENG block from the anatomical bases and to provide an up-to-date description of the technique, applications and effects.

EVIDENCE ACQUISITION: We reviewed the following medical literature databases for publications on PENG block: PubMed, Google Scholar, EMBASE, and Web of science until August 31st, 2020. Data regarding anatomy, indications, drugs and technique were also collected, reported and discussed.

EVIDENCE SYNTHESIS: From our search result we selected 57 relevant publications. Among them, 36 were case reports or case series and 12 publication were letters or correspondence; no RCT was identified. The main indication is the hip-related analgesia. The most commonly injected drug is a 20ml long-acting local anesthetic. There are some cases of femoral and obturator nerve block, but no major complication such as hematoma/bleeding or needle-related organ injury has been reported yet.

CONCLUSIONS: The PENG block is a promising technique. Randomized controlled trials of high methodological quality are required to further elaborate the role of this block.

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KEY WORDS: Anesthesia; Analgesia; Hip fractures.

The pericapsular nerve group (PENG) block is an ultrasound-guided approach first described by Giron-Arango *et al.* for the blockade of the articular branches of the femoral (FN), obturator (ON) and accessory obturator (AON) nerve that provide sensory innervation to the anterior hip capsule.[1] It has been developed as an alternative regional anesthesia technique for the management of acute pain after hip fractures, but its applications are expanding.[2-6]

Currently, the PENG block has been used to control and reduce pain in hip-related procedures.[7-18]

There are reports of PENG blocks used as surgical anesthetic techniques for hip arthroplasty (in combination with local anesthetic and intravenous analgesics) or hip arthroscopy (in combination with lateral femoral cutaneous nerve [LFCN] block).[19, 20] There is a report of a PENG block used as analgesic technique for

sickle cell disease vaso-occlusive crisis and a PENG radiofrequency ablation for osteoarthritis analgesia.[21, 22] There are also reports about the use of a PENG block for non-hip related interventions, such as leg vein ligation and stripping, medial thigh surgery, prevention of adductor muscle spasm during transurethral resection of bladder and below-knee amputation in association with popliteal sciatic nerve block.[23-26] These latter cases further extended the application of the PENG block beyond the hip-related area.

So far, most of the reports describe preoperative or postoperative single-shot blocks, while there are only few case reports of continuous PENG blocks.[27-30]

Due to the novelty of this technique, there are still ongoing debates about the best injection point as well as the best anesthetic concentration and the total volume to be injected.

The aim of this paper was to give an overview and highlight the knowledge gap about the PENG block from the anatomical bases, providing an up-to-date description of the technique, applications and effects.

The inguinal ligament runs from the anterior superior iliac spine (ASIS) to the tuberculum pubicum. Between the inguinal ligament and the hip bone there is a space where muscles, nerves and vessels run through. In this area, the arcus iliopectineous divides a laterally-located lacuna musculorum from a medially located lacuna vasorum.[31] The area of interest for the PENG block is the lacuna musculorum (Figure 1A).

The anatomical landmarks of the lacuna musculorum that are visible with ultrasound (US) are the ASIS, the anterior inferior iliac spine (AIIS), the pubic ramus and the iliopubic eminence (IPE) (Figure 1B). These landmarks outline the lacuna musculorum together with the arcus iliopectineous and the inguinal ligament, and allows the passage of the iliopsoas muscle, the FN and the LFCN.

Between the AIIS and the IPE there is a shallow groove over which the psoas component of the iliopsoas muscle passes. Superior and lateral to the psoas muscle there is the iliacus muscle, the other component of the iliopsoas muscle.

The iliopsoas muscle is composed of the psoas major muscle and the iliacus muscle. The psoas major originates along the lateral sides of the vertebral bodies of T12 and L1-L3 and their associated intervertebral discs. The iliacus muscle originates in the iliac fossa of the pelvis.[32] The psoas major joins with the iliacus at the level of the lacuna musculorum and together they cross the hip joint to insert on the lesser trochanter of the femur.

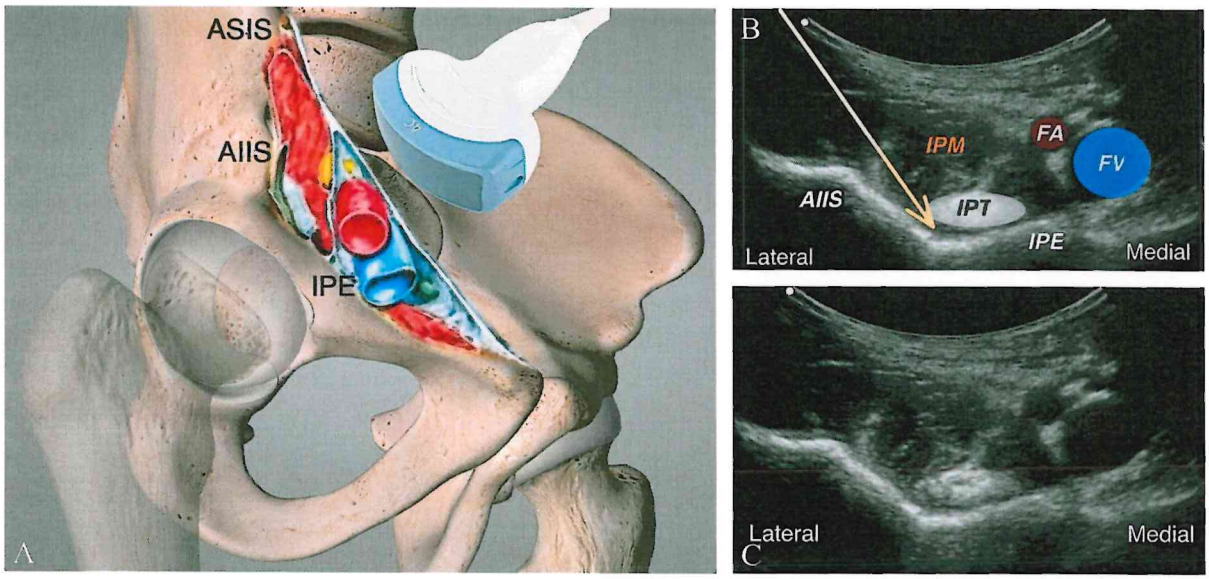

Figure 1.—A) The arcus iliopectineous divides the lacuna musculorum (lateral) from the lacuna vasorum (medial). B, C) 2D US scan for a PENG block.
Arrow: needle path.
ASIS: anterior superior iliac spine; AIIS: anterior inferior iliac spine; IPE: iliopubic eminence; IPT: iliopsoas tendon; IPM: iliopsoas muscle; FA: common femoral artery; FV: common femoral vein.

The nerves that provide sensory innervation to the anterior hip capsule are the FN, ON and AON.[1, 33, 34]

The FN is the largest branch of the lumbar plexus. It arises from the ventral rami of the 2nd, 3rd and 4th lumbar nerves. The hip articular branches are given off the FN distal to the lateral border of the psoas muscle, separating from the main nerve around the L5 level, and travel intramuscularly through the iliacus muscle, deep to the inguinal ligament. These branches terminate at the anterior capsule of the hip after passing over the periosteal surface of the pubis between the AIIS and the IPE while being covered by the psoas muscle.

Other sensory nerve branches are given off by the FN distally at articular level, piercing the iliopsoas muscle and innervating the anterior hip capsule or running inferiorly before recurring superiorly to innervate the joint capsule (Figure 2A). These branches could not be blocked with an ultrasound guided PENG block.[33]

The ON arises from the ventral rami of the 2nd, 3rd and 4th lumbar nerves and then enters the thigh by passing through the obturator foramen and then divides into an anterior and a posterior branch. Articular branches can arise either from the main trunk of the obturator nerve, or from the posterior or anterior division (Figure 2B).[33] The ON articular branches run in the bony thickening of the inferomedial acetabulum corresponding to the junction between pubic and ischial bones often referred to as the "incisura" of the acetabulum. The lateral edge of the obturator foramen lies medial to this point with the acetabular wall situated laterally.[35, 36]

The AON is present in about 30% of cases.[33] It arises from the ventral division of the 3rd and 4th lumbar nerves and then descends along the medial border of the psoas major and crosses the superior ramus of the pubis and passes under the pectineus muscle where divides into numerous branches (Figure 2C). One of them supplies the pectineus muscle, another is distributed to the hip joint while a third communicates with the anterior branches of the obturator nerve.[37]

The sensory innervation pattern of the hip capsule is different between the anterior and the posterior area. The anterior hip joint capsule contains the highest number of sensory fibers and mechanoreceptors.[1] Branches from both the FN and ON provide the innervation of the anterior hip capsule. The articular branches of the FN provide the majority of the innervation to the lateral and supero-medial hip capsule, while the ON branches innervate the inferomedial part of the capsule. The AON also contributes to the medial capsule innervation.[33] The proximal articular branches from the FN and the AON are consistently found between the AIIS and IPE, whereas the ON is located close to the inferomedial acetabulum. The posterior surface of the hip joint capsule is innervated by branches from the sciatic nerve: the superior gluteal nerve and the nerve to the quadratus femoris.[34]

The PENG block is supposed to target only the anterior branches to the hip joint. The sensory branches from the FN emerging distal to the inguinal ligament are reasonably excluded from this block.

Evidence acquisition

Study selection

Two authors (RDB. and EP) independently searched PubMed, Google Scholar, EMBASE,

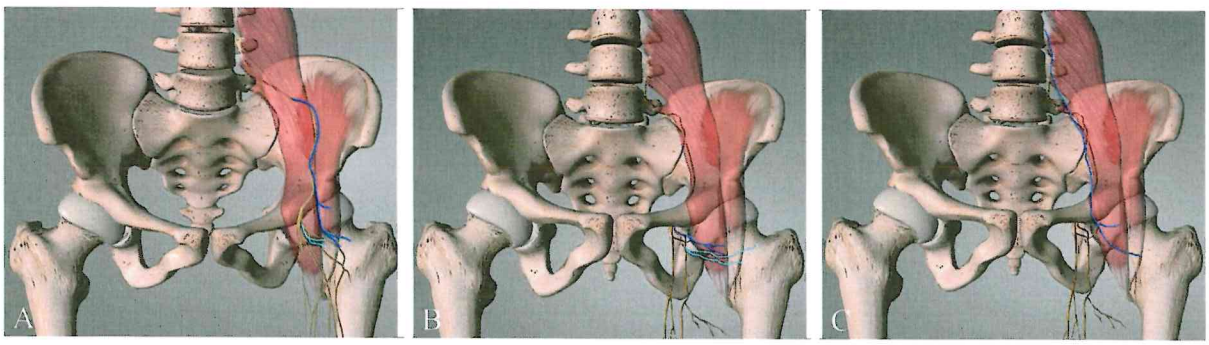

Figure 2.—Articular branches innervating the anterior hip capsule (dark grey: proximal/superior; light grey: distal/inferior). A) branches from the femoral nerve; B) branches from the obturator nerve; C) course of the accessory obturator nerve.

and Web of science from the first record to August 31, 2020 using the following terms: "PENG block," "pericapsular nerve group block," "pericapsular nerve group," "pericapsular nerve block." English-language restriction was applied. Each search was limited to humans. The two authors independently reviewed the identified studies. Full texts of potentially relevant articles were retrieved after screening titles and abstracts for eligibility. Disagreements were resolved by discussion with another author (GP). Additional studies were retrieved by reviewing the references of the relevant articles.

Inclusion and exclusion criteria

Inclusion criteria: 1) design – case reports, conference abstracts, letters, clinical trials, randomized controlled trials (RCTs); 2) population – adult and pediatric patients undergoing PENG block; and 3) intervention – ultrasound-guided PENG block using local anesthetics, with or without adjuvants.

Exclusion criteria was PENG block not performed.

Results

From our search result we selected 57 relevant publications. Among them, 36 were case reports or case series and 12 publication were letters or correspondence; no RCT was identified.

A summary of the published case reports is available in Supplementary Digital Material 1: Supplementary Table I.

Block technique

The PENG block is performed under US guidance, after adequate skin disinfection. The patient is placed in the supine position, allowing a comfortable placement of the US transducer and needle advancement. There is only a two-case-report of a PENG block performed in a lithotomy position.[25] One group of authors suggests a 90° abduction of hip and knee in the pediatric patient.[38] In most cases, a curvilinear low-frequency ultrasound probe (2-5 MHz) is initially placed in a transverse plane over the AIIS and then aligned with the pubic ramus by rotating the probe approximately 30-45 degrees (Figure 3A, B). Other authors preferred to recognize the hip joint at first with a transverse scan, move the probe cranially until the IPE and AIIS are visualized and then rotating the probe to align with the pubic ramus (Figure 3C, D). Regardless of the scanning technique, some authors prefer the use of a curvilinear probe due to the wider field of view and the relative depth of the target in the average adult (Figure 4 for curvilinear *vs.* linear probe).[39] There are also reports about the use of a linear high-frequency probe (8-13 MHz), especially for thin or young patients.[2, 8, 26, 39-43]

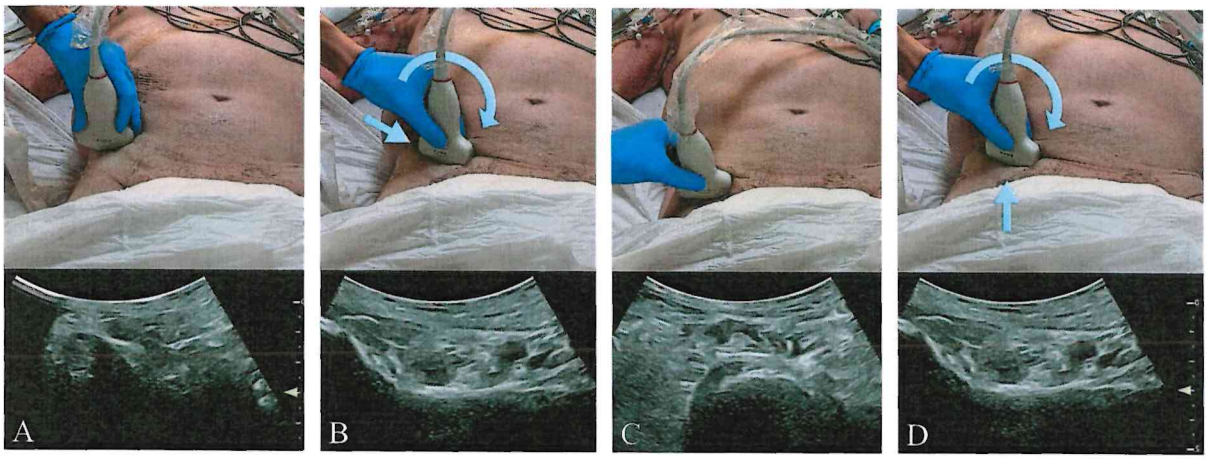

Figure 3.—Scanning technique 1: A, B) a curvilinear low-frequency ultrasound probe (2-5 MHz) is initially placed in a transverse plane over the AIIS (A), then is moved infero-medially and is aligned with the pubic ramus by rotating the probe approximately 30-45 degrees (B). Scanning technique 2: C, D) a curvilinear low-frequency ultrasound probe (2-5 MHz) is initially placed in a transverse plane over the hip joint (C), is moved cranially until the IPE and AIIS are visualized and then rotated approximately 30-45 degrees (D).

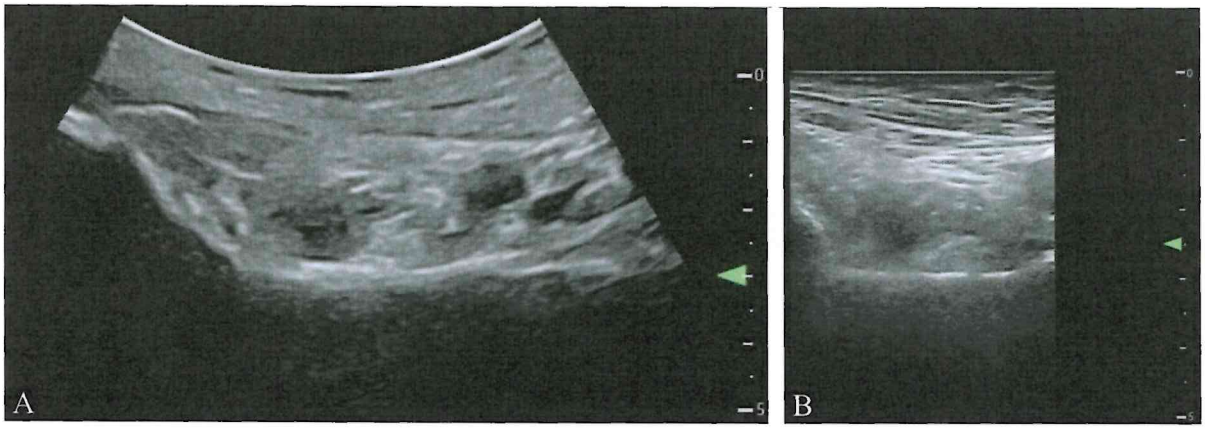

Figure 4.—A) Comparison between curvilinear; and B) linear probe scan on the same patient.

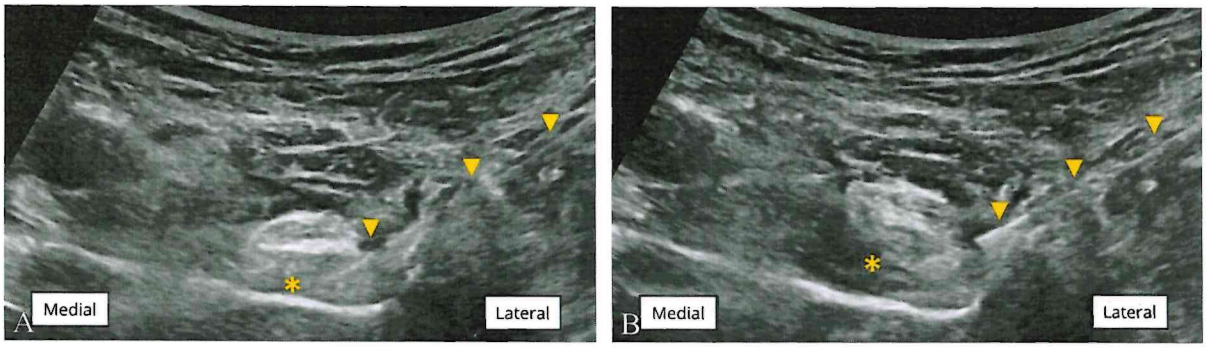

Figure 5.—PENG block: A) before; and B) after the injection of 15 mL of local anaesthetic below the iliopsoas tendon. Arrow heads: needle path; asterisk: needle tip.

Once the US probe is in the correct place, the structures that are observed in this view are the IPE, the iliopsoas muscle and tendon, the femoral artery and the pectineus muscle (Figure 1B, C).

The needle, usually a 22-G 80-mm echogenic device, is inserted from lateral to medial with an in-plane approach to place the tip in the plane between the psoas tendon anteriorly and the pubic ramus posteriorly (Figure 5A). There is also a report of an out-of-plane approach.[44]

After needle insertion and following negative aspiration, the local anesthetic is injected (Figure 5B). The volume ranges from 8 to 30 mL, even though most of the authors used a volume of 20 mL. This fascial plane appeared to continue in the hip pericapsular plane (Figure 6, 7).[45] Indeed, some authors hypothesized that the local anesthetic could spread through the lacuna musculorum and reach the subpectineal plane by following the ilioinfratrochanteric muscular bundle, below the iliopsoas tendon.[46]

The agent of choice is usually a diluted long-acting local anesthetic (L-bupivacaine, bupivacaine or ropivacaine; concentration ranging from 0,25% to 0,5%), sometimes in association with a medium-acting local anesthetic (lidocaine 1% to 2%). There are papers reporting the association with dexamethasone or epinephrine as adjuvants (Supplementary Digital Material 1: Supplementary Table I).

Indications

The majority of PENG blocks have been performed for hip-related analgesia (hip fractures, pelvic fractures, hip surgery).[1,2,7,9-12,27,28,41-43,46-49] This is the main indication for this block, due to the higher number of reported cases. Regarding hip fracture, the main indication reasonably appears to be the one located to the head or neck of the femur.[13] Regarding leg and thigh surgery, there are few reports about this topic. In those cases, the authors used a high-volume block (30

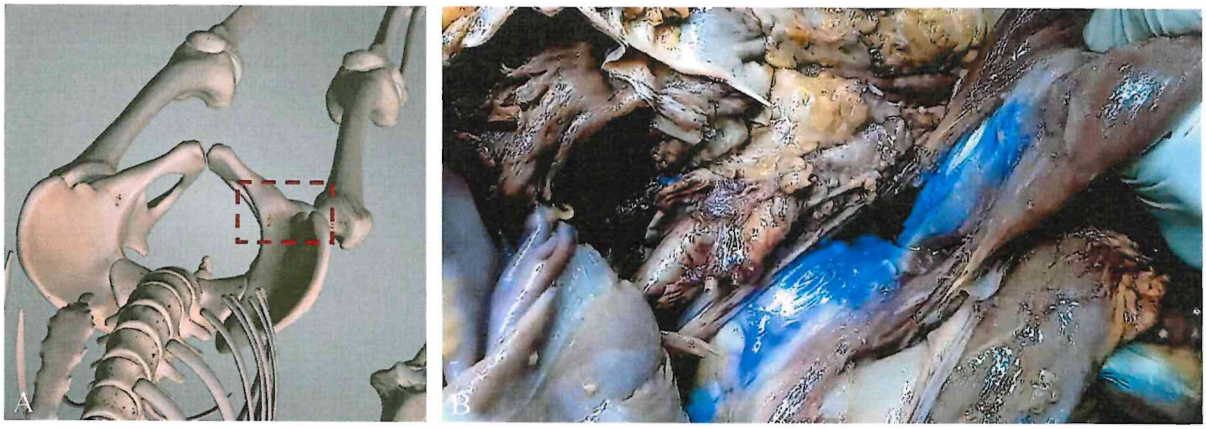

Figure 6.—Cadaveric section: 10 cc dye spread in the PENG/pericapsular area. The psoas muscle has been partially sectioned and is handheld in the up-right corner of the image (A).

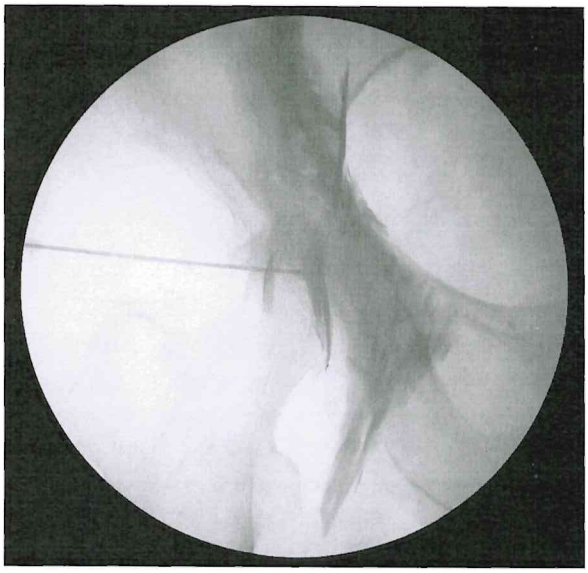

Figure 7.—Right hip. Cadaveric fluoroscopic injection: 10 cc contrast spread in the PENG/pericapsular area.

ml of local anesthetic).[23-25, 50] For each situation, we remind the reader that there are only case reports while no trials have been published yet.

Complications

So far, no major complications such as hematoma/bleeding or needle-related organ injury have been reported.

On the other side, there are some reports of FN and ON nerve block, that were either inadvertent or sought-after. An involvement of the FN has been reported in four patients.[2, 50] An ON block has also been reported in nine patients.[23-26, 50] Concerns regarding possible intravascular or blood collection catheterization have been arisen for continuous PENG block.[29]

Discussion

The PENG block is a promising new technique, whose indications and applications are still expanding. Since its first description there is still limited literature available, mainly made up of case reports and correspondence, despite the spread of this block in clinical practice and scientific meetings.[51] This block was originally developed to provide analgesia in patients with a hip fracture and targets the articular branches of the FN, ON and AON to the hip capsule.[33, 47, 52]

In 2018, a similar block was already described in cadavers, called the iliopsoas plane block (IPB).[53] The IPB is an injection between the iliopsoas muscle and the iliofemoral ligament. As described in a later paper, a modified lateral-to-medial needle approach was used to anesthetize all the hip articular branches from the FN, possibly along with the branches from the AON.[54] The ON hip articular branches are not supposed to be blocked by this approach, since the iliopectineal bursa obstructed the spread of the local anesthetic towards these branches.

Regarding the indications, most of the literature available appears to stick with the original one: hip fracture and hip related pain (surgery, dislocation) analgesia, with more than a hundred cases described. All other indications such as thigh and leg surgeries, have very limited cases reported.[23, 24]

Some authors describe a complete FN and ON

block after PENG block.[23-26, 50] In the work by Yu *et al.* they describe two cases of inadvertent quadriceps weakness with inability to perform a straight leg raise.[2] In both cases, the complete blockade of the FN was not the original intention. They stated that in those two patients the procedure was difficult, leading in a more cranial/medial and superficial injection than required. They hypothesized that an unwanted spread of local anesthetic led to a FN or fascia iliaca block. A similar hypothesis was formulated in an article where the analgesia extended to the distal femoral area during a continuous PENG block.[55]

In other reports instead, the blockade of the FN as well as the ON was a desired result. In these cases, it appears that the injection point was slightly more medial than the point described by the original authors.[23, 24, 48] As suggested by Yu *et al.*, it is possible that a more medial injection or an inadvertent injection above the fascial plane covering the inferior surface of the iliopsoas muscle, could end up in an anesthetic diffusion through the muscle towards the femoral nerve. To prevent the non-perforation of this fascia, the suggested simple solution is to rotate the needle between the thumb and index finger when the needle tip is in contact with the bone. Mistry *et al.* also tried to explain this issue by dividing the iliopsoas into three horizontal zones: the best zone to have the local anesthetic spread without motor blockade is the deepest one.[42] We also hypothesize that a high-volume, medial injection, could also allow the anesthetic to spread towards the ON. An ON block was indeed obtained in the reports by Ali Ahiskalioglu *et al.* using a 30 mL volume of local anesthetic and with an injection point slightly more medial than the midpoint between the AIIS and IPE.[24, 25] This hypothesis is also supported by other authors that suspected a lumbar plexus-like effect when high volumes of local anesthetic are used.[23, 48, 50] We remind the readers that there are many techniques available to efficiently block the ON, an example is the US guided subpectineal approach.[56]

It appears that this block could eventually result in an anesthetic motor-blocking technique, even though it was originally developed as a motor-sparing analgesic technique for hip-derived pain.

In a cadaveric study, an injection during fluoroscopy showed a contrast diffusion towards the posterior surface of the hip, thus hypothesizing the possible blockade of part of the sciatic nerve.[57]

Regarding the complications, no major events such as hematoma/bleeding or needle-related organ injury have been reported yet.

There have been reported three cases of blood aspiration through a catheter during its placement for continuous PENG block.[29] In all cases, a more medial (0.5-1 cm) repositioning of the catheter resulted in negative aspiration. The hypothesis for such occurrence was a blood collection in the psoas bursa or within the iliopsoas muscle, or intravascular placement.

There has been also a discussion regarding the "shallowness" of the PENG block, but the safety of this block has not been studied in the patients taking anticoagulant medications.[39]

Additionally, it should be highlighted that with a medial puncture approach there could be a theoretical risk of femoral nerve injury. The femoral nerve must always be identified prior to needle insertion, as the nerve may lie in, or close to, the needle path. This issue could be avoided preferring a lateral-to-medial puncture and not vice versa. The LFCN of the thigh also lies in close proximity to the needle insertion site near the ASIS. The LFCN has a variable course as it passes into the anterior thigh below the inguinal ligament. To avoid inadvertent LFCN injury the puncture should not be below the inguinal ligament.[39] There was also a discussion about a possible urethra or bladder injury, but it was also only a speculation and no case has been reported.[38, 40]

Conclusions

To date, the PENG block is a young, promising technique. Even though it is an exponentially spreading technique, there could be still a lacking knowledge about its indications, contraindications, technique, and drugs to be injected. Moreover, there is no data yet regarding the complications and all the literature available is at the two lowest quality levels of the hierarchy of evidence. Along with the iliopsoas plane block and the US guided local infiltration analgesia, they are the only techniques available to possibly

provide hip analgesia without motor block.[54, 58] Even though there are no trials to establish the efficacy, safety, and advantages of the PENG block over other techniques, it represents a great promise for a future approach to opioid-sparing and early-mobilization analgesic strategies.

Key messages

- PENG block is a promising analgesic technique for hip pain.
- PENG block aims to provide hip analgesia without motor block.
- PENG block could provide opioid sparing and early mobilization in hip surgery.
- High quality clinical trials are required to establish the efficacy of PENG block.

References

1. Girón-Arango L, Peng PW, Chin KJ, Brull R, Perlas A. Pericapsular Nerve Group (PENG) Block for Hip Fracture. Reg Anesth Pain Med 2018;43:859–63.

2. 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;44:611–3.

3. Peng P. Reply to Gofeld, pericapsular nerve group (PENG) block: an ethical and academic perspective. Reg Anesth Pain Med 2019;44:905–6.

4. Gofeld M. Pericapsular nerve group (PENG) block: an ethical and academic perspective. Reg Anesth Pain Med 2019;44:905–6.

5. Peng PW, Perlas A, Chin KJ. Reply to Dr Nielsen: pericapsular Nerve Group (PENG) block for hip fracture. Reg Anesth Pain Med 2019;44:415–6.

6. Fusco P, De Sanctis F, De Paolis V, Di Carlo S, Di Martino E, Volpe D, *et al.* Could US-guided PENG block pass the ICU door? First reported case in a multiple-fracture ICU patient. Minerva Anestesiol 2020;86:884–5.

7. Roy R, Agarwal G, Pradhan C, Kuanar D. Total postoperative analgesia for hip surgeries, PENG block with LFCN block. Reg Anesth Pain Med 2019;44:684.

8. Girón-Arango L, Roqués V, Peng P. Reply To Dr Roy et al: Total postoperative analgesia for hip surgeries: PENG block with LFCN block. Reg Anesth Pain Med 2019;44:684–5.

9. Orozco S, Muñoz D, Jaramillo S, Herrera AM. Pericapsular Nerve Group (PENG) block for perioperative pain control in hip arthroscopy. J Clin Anesth 2020;59:3–4.

10. Ueshima H, Otake H. Pericapsular nerve group (PENG) block is effective for dislocation of the hip joint. J Clin Anesth 2019;52:83.

11. Ince I, Kilicaslan A. Combination of Lumbar Erector Spinae Plane Block (LESP) and Pericapsullar Nerve Group (PENG) block in hip surgery. J Clin Anesth 2020;61:109672.

12. Ince I, Kilicaslan A, Kutlu E, Aydin A. Combined pericapsular nerve block (PENG) and lumbar erector spinae plane (ESP) block for congenital hip dislocation surgery. J Clin Anesth 2020;61:109671.

13. Koyuncu O, Hakimoğlu S, Polat ST, Kara MY. [Three blocks, including Pericapsular Nerve Block (PENG) for a femoral shaft fracture pain]. Rev Bras Anestesiol 2019;69:638–9. [Portuguese]

14. Casas Reza P, Diéguez García P, Gestal Vázquez M, Sampayo Rodríguez L, López Álvarez S. Pericapsular nerve group block for hip surgery. Minerva Anestesiol 2020;86:463–5.

15. Pagano T, Scarpato F, Chicone G, Carbone D, Bussemi CB, Albano F, *et al.* Analgesic evaluation of ultrasound-guided Pericapsular Nerve Group (PENG) block for emergency hip surgery in fragile patients: a case series. Arthroplasty. 2019;1:18.

16. 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. Can J Anaesth 2020;67:1673–4.

17. Kukreja P, Avila A, Northern T, Dangle J, Kolli S, Kalagara H. A Retrospective Case Series of Pericapsular Nerve Group (PENG) Block for Primary Versus Revision Total Hip Arthroplasty Analgesia. Cureus 2020;12:e8200.

18. Fusco P, Petroni GM, Ciccozzi A, Tullj S, Chiavari R, Marinangeli F. The role of the PENG block in hip fracture in elderly patient with severe comorbidities. Minerva Anestesiol 2020;86:1112–3.

19. Sandri M, Blasi A, De Blasi RA. PENG block and LIA as a possible anesthesia technique for total hip arthroplasty. J Anesth 2020;34:472–5.

20. Talawar P, Tandon S, Tripathy DK, Kaushal A. Combined pericapsular nerve group and lateral femoral cutaneous nerve blocks for surgical anaesthesia in hip arthroscopy. Indian J Anaesth 2020;64:638–40.

21. Wyatt KE, Pranav H, Henry T, Liu CJ. Pericapsular nerve group blockade for sickle cell disease vaso-occlusive crisis. J Clin Anesth 2020;66:109932.

22. Jaramillo S, Muñoz D, Orozco S, Herrera AM. Percutaneous bipolar radiofrequency of the pericapsular nerve group (PENG) for chronic pain relief in hip osteoarthrosis. J Clin Anesth 2020;64:109830.

23. Aydin ME, Borulu F, Ates I, Kara S, Ahiskalioglu A. A Novel Indication of Pericapsular Nerve Group (PENG) Block: Surgical Anesthesia for Vein Ligation and Stripping. J Cardiothorac Vasc Anesth 2020;34:843–5.

24. Ahiskalioglu A, Aydin ME, Ahiskalioglu EO, Tuncer K, Celik M. Pericapsular nerve group (PENG) block for surgical anesthesia of medial thigh. J Clin Anesth 2020;59:42–3.

25. Ahiskalioglu A, Aydin ME, Ozkaya F, Ahiskalioglu EO, Adanur S. A novel indication of Pericapsular Nerve Group (PENG) block: prevention of adductor muscle spasm. J Clin Anesth 2020;60:51–2.

26. Ueshima H, Otake H. Below-knee amputation performed with pericapsular nerve group and sciatic nerve blocks. J Clin Anesth 2019;54:45.

27. Santos O, Pereira R, Cabral T, Lages N, Machado H. Is Continuous PENG Block the New 3-in-1. J Anesth Clin Res 2019;10:2.

28. Soares J, Veiga M, Galacho J, Ormonde L. Efficacy of continuous pericapsular nerve group (PENG) block for pain relief after hemiarthroplasty of the hip: a case report. Reg Anesth Pain Med 2019;44:210.

29. Del Buono R, Padua E, Pascarella G, Soare CG, Barbara E. Continuous PENG block for hip fracture: a case series. Reg Anesth Pain Med 2020;45:835–8.

30. Wyatt K, Zidane M, Liu CJ. Utilization of a Continuous Pericapsular Nerve Group (PENG) Block with an Opioid-Sparing Repair of a Femoral Neck Fracture in a Pediatric Patient. Case Rep Orthop 2020;2020:2516578.

31. Tubbs RS. Sobotta Anatomy textbook. Munich: Elsevier; 2019.

32. Anastasi G, Capitani S, Carnazza M, Cinti S, Cremona O, De Caro R, *et al.* Trattato di Anatomia umana. Milan: Edi-Ermes; 2010. p.256–78

33. Short AJ, Barnett JJ, Gofeld M, Baig E, Lam K, Agur AM, *et al.* Anatomic Study of Innervation of the Anterior Hip Capsule: Implication for Image-Guided Intervention. Reg Anesth Pain Med 2018;43:186–92.

34. Birnbaum K, Prescher A, Hessler S, Heller KD. The sensory innervation of the hip joint—an anatomical study. Surg Radiol Anat 1997;19:371–5.

35. Bhatia A, Hoydonckx Y, Peng P, Cohen SP. Radiofrequency Procedures to Relieve Chronic Hip Pain: An Evidence-Based Narrative Review. Reg Anesth Pain Med 2018;43:72–83.

36. Locher S, Burmeister H, Böhlen T, Eichenberger U, Stoupis C, Moriggl B, *et al.* Radiological anatomy of the obturator nerve and its articular branches: basis to develop a method of radiofrequency denervation for hip joint pain. Pain Med 2008;9:291–8.

37. Gray H. Gray's anatomy: with original illustrations by Henry Carter. London: Arcturus Publishing, 2009. p.1316–451

38. Aksu C, Cesur S, Kuş A. Pericapsular Nerve Group (PENG) block: controversial points about anatomical differences. J Clin Anesth 2020;61:109701.

39. Black ND, Chin KJ. Pericapsular nerve group (PENG) block: comments and practical considerations. J Clin Anesth 2019;56:143–4.

40. Mistry T, Sonawane KB, Kuppusamy E. PENG block: points to ponder. Reg Anesth Pain Med 2019;44:423–4.

41. Orozco S, Muñoz D, Jaramillo S, Herrera AM. Pediatric use of Pericapsular Nerve Group (PENG) block for hip surgical procedures. J Clin Anesth 2019;57:143–4.

42. Mistry T, Sonawane KB. Gray zone of pericapsular nerve group (PENG) block. J Clin Anesth 2019;58:123–4.

43. Aksu C, Cesur S, Kuş A. Pericapsular nerve group (PENG) block for postoperative analgesia after open reduction of pediatric congenital dysplasia of the hip. J Clin Anesth 2020;61:109675.

44. Acharya U, Lamsal R. Pericapsular Nerve Group Block: An Excellent Option for Analgesia for Positional Pain in Hip Fractures. Case Rep Anesthesiol 2020;2020:1830136.

45. Tran J, Agur A, Peng P. Is pericapsular nerve group (PENG) block a true pericapsular block? Reg Anesth Pain Med 2019;44:257.

46. Fusco P, Di Carlo S, Paladini G, Scimia P, Di Martino E, Marinangeli F, *et al.* Could the combination of PENG block and LIA be a useful analgesic strategy in the treatment of postoperative pain for hip replacement surgery? Reg Anesth Pain Med 2019;44:531.

47. Ueshima H, Otake H. Clinical experiences of pericapsular nerve group (PENG) block for hip surgery. J Clin Anesth 2018;51:60–1.

48. Bilal B, Öksüz G, Boran OF, Topak D, Doğar F. High volume pericapsular nerve group (PENG) block for acetabular fracture surgery: A new horizon for novel block. J Clin Anesth 2020;62:109702.

49. Luftig J, Dreyfuss A, Mantuani D, Howell K, White A, Nagdev A. A new frontier in pelvic fracture pain control in the ED: successful use of the pericapsular nerve group (PENG) block. Am J Emerg Med 2020;38:2761.e5–9.

50. Ahiskalioglu A, Aydin ME, Celik M, Ahiskalioglu EO, Tulgar S. Can high volume pericapsular nerve group (PENG) block act as a lumbar plexus block? J Clin Anesth 2020;61:109650.

51. Abstracts of the European Society of Regional Anesthesia. September 11–14, 2019. Reg Anesth Pain Med. 2019;44(1).

52. Ayub A, Bhoi D, Tangirala N, Narayanan MV. Initial experience of pericapsular nerve group block for positioning during neuraxial block in patients with hip fracture. Indian Journal of Pain. 2020;34:58–9.

53. Nielsen ND, Greher M, Moriggl B, Hoermann R, Nielsen TD, Børglum J, *et al.* Spread of injectate around hip articular sensory branches of the femoral nerve in cadavers. Acta Anaesthesiol Scand 2018;62:1001–6.

54. Nielsen ND, Bendtsen TF. Motor-sparing regional analgesia for hip-derived pain. Reg Anesth Pain Med 2019;44:415.

55. Prado-Kittel C, Zumelzu-Sánchez P, Palma-Licandeo A, Faúndez-Lillo G, Ellenberg-Oyarce K, Jorquera-Adarme B. [Continuous pericapsular nerve group blockade as analgesia for fracture of the posterior column and wall of the acetabulum; a case report and description of infusion regimen for extending analgesic effect to the distal femoral area]. Rev Esp Anestesiol Reanim 2020;67:159–62. [Spanish]

56. Nielsen TD, Moriggl B, Søballe K, Kolsen-Petersen JA, Børglum J, Bendtsen TF. A Cadaveric Study of Ultrasound-Guided Subpectineal Injectate Spread Around the Obturator Nerve and Its Hip Articular Branches. Reg Anesth Pain Med 2017;42:357–61.

57. Yamak Altinpulluk E, Galluccio F, Salazar C, Espinoza K, Olea MS, Hochberg U, *et al.* Peng block in prosthetic hip replacement: A cadaveric radiological evaluation. J Clin Anesth 2020;65:109888.

58. Del Buono R, Pascarella G, Costa F, Barbara E. Ultrasound-guided local infiltration analgesia for hip surgery: myth or reality? Minerva Anestesiol 2019;85:1242–3.

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