Beyond the pericapsular nerve group (PENG) block: A narrative review

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BEYOND THE PERICAPSULAR NERVE GROUP (PENG) BLOCK: A NARRATIVE REVIEW

ABSTRACT
The Pericapsular Nerve Group (PENG) block shows promising results in providing pain relief with a potential motor-sparing effect in hip fracture patients. In this narrative review, we analyze the published articles, and we describe the structures achieved when performing the block. We conducted a literature search to identify the articles performing the PENG block, in the adult or pediatric population, from November 1, 2018, to May 15, 2021. Of the 68 selected articles, 38 were considered eligible, including one double-blinded randomized comparative trial, four observational studies, and 33 case series and case reports. The technique was described in both acute and chronic pain settings, mainly performed as single-shot. All studies described effective analgesia. Quadriceps weakness was experienced in some patients. It has been described as easy to perform and with a low rate of complications. It lacks, however, adequately powered randomized controlled trials to assess its clinical value and efficacy.

Key words: Nerve Block, Pain Management, Acute Pain, Chronic Pain

INTRODUCTION
Over the last few years, regional anesthesia has witnessed the emergence of various novelties in ultrasound-guided techniques. The Pericapsular Nerve Group (PENG) block, firstly described in 2018 by Girón-Arango et al.¹, promptly caught the attention with its promising results in providing pain relief in the perioperative setting and a potential motor-sparing effect in patients with hip fractures. It targets the most richly innervated segment of the hip joint, the anterior capsule.

Advantages of peripheral nerve blocks over systemic analgesia for pain treatment after hip fractures were described recently in a Cochrane review². Compared to systemic analgesia, the authors reported on pain on movement reduction of 3.4 in a 10-points Numerical Rating Scale 30 minutes after block placement, reduced time to first mobilization, reduced complications secondary to immobilization, like pneumonia, and higher patient satisfaction.
The use of peripheral nerve blocks for pain management after a hip fracture has a long and diverse history, including the fascia iliaca, femoral nerve (FN), psoas compartment, obturator nerve (ON), or lateral femoral cutaneous nerve (LFCN) blocks.

Since its description, several reports or letters have been published hypothesizing the mechanism of action of the PENG block, efficacy, local anesthetics (LA) distribution and optimal doses, and the inadvertent risk of motor weakness. Additionally, its applicability now travels beyond the hip pathology and new settings have been described.

The literature available on the PENG block is still scarce and, in this review, we analyze the published articles related to the technique in different clinical scenarios, the LA used, its effectiveness, and complications reported, and we further describe the structures achieved when performing the PENG block.

Relevant Anatomy

In 1997, Birnbaum et al. reported on the femoral nerve's articular branches to innervate the anterolateral hip joint capsule and the articular branches of the obturator nerve to be responsible for the anteromedial portion. The posterior and inferior portions were innervated by branches from the sciatic or superior gluteal nerves. Gerhardt et al., in a histological study, established a predominant presence of nociceptive fibers in the anterior and superolateral portions of the hip joint capsule. In the posterior and inferior sections, the neural fibers found were identified as mechanoreceptors.

An accessory obturator nerve (AON), present in 10% to 30% of patients, has also been reported to consistently innervate the hip joint capsule. It arises whether from the ventral branches of the L3 and L4 spinal nerves or the ON directly and travels by the psoas major at its medial margin, crosses the superior pubic ramus dorsal to the pectineus muscle, over the iliopubic eminence (IPE), to terminate on the hip capsule.

Thus, the three nerves (FN, ON, AON) are assumed to be the primary mediators of pain in patients with hip fractures, suggesting that these should be the main targets for hip analgesia. This premise was recently confirmed by Short et al. in their anatomical study. The authors describe superior accountability from the AON and FN than formerly postulated in the innervation of the anterior portion of the capsule. Furthermore, this study identified the relevant landmarks for those articular branches. Between the anterior inferior iliac spines (AIIS) and the
IPE, one could consistently find the high articular branches of the FN and the AON, whereas, closer to the inferomedial acetabulum, the articular branches of the ON. This was the core information that was endorsed in the development of the PENG block. It aims at blocking those branches while taking advantage of ultrasound technology.

Technique description

The procedure is performed under ultrasound guidance using a curvilinear low-frequency ultrasound probe in the supine position. After identifying the AIIS with the probe positioned in a transverse plane, the probe should be rotated approximately 45 degrees to be in the orientation of the pubic ramus. When reaching this position, the authors describe the identification of the iliopsoas muscle and tendon sitting on the IPE, and the femoral artery and the pectineus muscle, more medially.¹

METHODS

In this narrative review, we performed a literature search using PubMed, MEDLINE, Cochrane Library, and Google Scholar for published articles related to the PENG block, from November 1, 2018, to May 15, 2021, in the English language. We used the keywords "pericapsular nerve group", "peri-capsular nerve group", and "PENG block". We included clinical trials, observational studies, case series, case reports, and letters to the editor, describing the procedure either in the adult or pediatric population. Excluded articles included those other than the English language, duplicate articles, and articles not related to the PENG block. Initially, 68 articles were identified. Of these, 6 articles were excluded, based on their titles or abstracts if they were not associated with the PENG block. A comprehensive reading of the 62 articles was completed, of which 24 were excluded for not being relevant in the context of the present review or not a technique description in adult or pediatric patients.

At last, 38 studies were included (Figure 1), and data extracted related to the number of individuals involved, the intervention performed, the type of LA used, catheter introduction or single-shot, associated regional anesthesia techniques, application in acute or chronic pain setting, pain scores, complications, and other relevant topics.
RESULTS

The studies this review comprises include one double-blinded randomized comparative trial, four observational studies, 13 cases series, and 20 case reports.

Table 1 summarizes the results of the double-blinded randomized comparative trial (URL: https://www.trialregister.nl/trial/8043) and the observational studies.

Lin et al. compared the PENG block with the FN block for hip surgery analgesia. The authors randomly allocated 60 patients with hip fracture presenting for surgery to receive the PENG block or the FN block (20 mL of 0.75% ropivacaine were used in both). On the post-anesthesia care unit (PACU) 90% of the patients in the PENG group experienced none or mild pain, compared to 57% in the FN block group (p=0.04). In the latter group, 33% of the patients showed reduced quadriceps strength on day 1, compared to 7% on the PENG group (p=0.004). Finally, 97% of the PENG group patients were satisfied with the analgesia received, in comparison to 70% in the FN block group (p=0.02).

In a prospective study, Sahoo et al. aimed at evaluating the decrease in pain score at rest and with passive movement after PENG block, and the efficacy of the analgesia when sitting hip fracture patients for spinal anesthesia. 30 minutes after the administration of 20 mL of 0.25% bupivacaine with 4 mg dexamethasone, the mean pain score decreased from 7.45±1.53 (mean±SD) to 1.1±1.07 at rest, and from 9.45±0.75 to 2.35±1.34 with passive movement (P<0.001). Optimal positioning was achieved in 75% of patients.

Tables 2 to 4 summarize the results of all case reports and case series, totaling 122 patients. The block was performed in the acute pain setting in 30 reports (118 patients) and it was mainly performed in the context of hip surgery. Indications also included two cases of vein ligation and stripping, a case of transurethral resection of laterally located bladder tumors, and a hip and thigh vaso-occlusive crisis, due to a sickle cell disease. The single-shot technique was the most regularly used, including 25 reports and 94 patients (Table 2). LA used included lidocaine, ropivacaine, bupivacaine, and levobupivacaine, in different concentrations, with 4 mg of dexamethasone in some cases. The volume administered ranged from 10 to 40 mL. Sensory loss of the FN, ON, LFCN, and genitofemoral nerve was frequently reported after performing the block. No complications were reported, apart from three cases of quadriceps motor weakness and inability to perform a straight leg raise. LA used in these scenarios were 15 mL 0.5% bupivacaine plus 15 mL 2% lidocaine, 20 mL 0.5% bupivacaine
with 1:400 000 epinephrine and 50 mcg/mL dexamethasone and 20 mL 0.25% bupivacaine with 1:400 000 epinephrine and 50 mcg/ml dexamethasone.

Five reports (24 patients) used continuous LA infusion after insertion of a catheter, also in acute pain setting (Table 3). The catheter was kept for one to three days, with perfusion of 5 to 6 mL/h. Pain scores were inferior to 3 out of 10 points. Three cases of intravenous catheter placement were reported.

Three reports (four patients) describe the PENG block application for chronic pain treatment (Table 4), with decreased pain scores and no complications.

Pediatric use of the PENG block was evaluated in four case reports for acute pain management, with good outcomes, including one that used a continuous infusion through a catheter.26,29,30,34

DISCUSSION

The literature available on the PENG block, while mainly considering perioperative analgesia for hip surgery, has been showing that the procedure offers effective pain relief with preserved quadriceps strength.

Lin et al.7 tested the PENG block in a double-blinded randomized comparative fashion, conceding it as a possible ideal regional technique for hip surgery. Such technique should allow a significant pain reduction while avoiding delayed mobilization and discharge. The authors found the technique to be more successful than FN block in controlling pain and preventing quadriceps weakness.

Aydin et al.38 described a new indication for the PENG block, beyond the hip pathology. The patients went through vein ligation and stripping in the segment of both FN and ON dermatomes under an effective PENG block for surgical anesthesia. The authors used 30 mL of LA and reported to have effectively blocked not only the FN and ON dermatomes, but also the LFCN and genitofemoral nerve dermatomes, in both patients. They proposed that, when using higher volumes than the 20 mL originally described, the PENG block will resemble a lumbar plexus block.

The skin of the lateral thigh can be anesthetized after blocking the LFCN. This procedure is vastly performed and is of pertinence for hip surgery. The nerve enters the thigh just below the inguinal ligament and is typically found 10-15 mm medial to the anterior superior...
iliac spine (ASIS). It then passes laterally over the sartorius muscle, where it divides into multiple branches to supply the skin of the thigh on its lateral aspect as far distal as the knee. The block can be performed after ultrasound-guided infiltration immediately under the inguinal ligament 1 to 2 cm medial to the ASIS, with a high success rate. When preparing to perform the PENG block, with the probe aligned parallel to the inguinal ligament, the anatomical structures to execute the LFCN block can be easily identified by displacing the probe in an oblique direction towards lateral and superior until the ASIS is seen. The nerve should appear between the tensor fasciae latae muscle and sartorius muscle or superficial to the latter.

Additionally, Santos et al. reported a successful case of a PENG block with a perineural catheter, with the tip being placed between the psoas tendon anteriorly and the pubic ramus posteriorly. The authors described, as well, that analgesia beyond the FN and ON territories was observed, namely in the LFCN. Similarly, Altinpulluk et al. reported on the possibility to reach the LFCN when performing a PENG block, after injecting different volumes of LA in the targeted area. This LFCN coverage seems to be an additional potential of the PENG block, supported by the previously published articles.

Based on a recent anatomic study, the PENG block was developed to target the articular branches of the FN and AON between the AIIS and IPE. The authors reported having accomplished their purpose, although being unable to assess the LA medial spreading to reach the interfascial plane between the pectineus and obturator externus muscles. This subpectineal plane corresponds to the location of the articular branches of ON and is perceptible using ultrasound. It was previously described as a target point for the ON. According to that previously described technique, Nielsen et al. conducted a cadaveric study to evaluate the proximal spread around the ON articular hip branches after ultrasound-guided injection in the subpectineal plane. The authors demonstrated that injection of 15 mL of dye spread proximally, with a considerably high success rate, into the obturator canal and to the ON and AON articular branches to the hip capsule. The dye consistently spread dorsally through the pectineus muscle to reach its lateral limit, where the AON typically is located and, when present, it spread around the nerve.

One could assume that, given the spreading pattern after this ultrasound-guided subpectineal technique, which shows consistent dispersion along the deep face of the pectineus
muscle to reach its lateral margin, the reverse trajectory may well be accomplished when executing the PENG block. Figure 2 shows the structures present in the targeted area.

Although the analgesic effect of the PENG block was notable and reproducible in different centers\textsuperscript{21,38,43}, the distribution of injectate relative to the hip capsule articular branches innervating the joint was not defined. This question was addressed\textsuperscript{51} and 10 and 20 mL of dye were injected in cadavers, to conclude that the anterior portion of the hip capsule, identified as the nociceptive segment, was stained after the spread of the dye through the bursal space between the iliopsoas and anterior hip joint capsule. The authors concluded that this pattern supports the “true” pericapsular nature of the PENG block, by reaching the articular branches of the FN, ON, and AON. Another cadaveric study using 10 mL of contrast showed the contrast to the extent to the joint space and its accumulation in the lower joint recess.\textsuperscript{48}

**CONCLUSION**

The main issue with the PENG block is the lack of adequately powered RCT comparing it with the more commonly used epidural or other peripheral nerve blocks.

The PENG block is increasingly recruiting supporters with its, although limited to case series, encouraging results, and motor-sparing effect, denoting a significant benefit. It may arise as an easier and safer good alternative to other techniques, such as the lumbar plexus block. The latter exemplifies an advanced procedure more difficult to accomplish, with a higher rate of complications associated.

Because the PENG block is a recently described technique, further investigations assessing its clinical value, efficacy, and the diffusion of the solution to confirm the coverage area need to be developed, as well as to determine its optimal volume and additional indications.
REFERENCES


35. Talawar, P., Tandon, S., Tripathy, D. K. & Kaushal, A. Combined pericapsular nerve


FIGURES CAPTIONS

**Figure 1.** Algorithm of the selection of articles in different phases for this review.

**Figure 2.** Ultrasound illustration of the region of pertinence to the PENG block. AIIS: anterior inferior iliac spine; FN: femoral nerve; FA: femoral artery; FV: femoral vein; SM: sartorius muscle; IPT: iliopsoas tendon; PeM: pectineus muscle.
Table 1. Reported studies of the PENG block

<table>
<thead>
<tr>
<th>Study type</th>
<th>N</th>
<th>Procedure</th>
<th>Groups</th>
<th>LA</th>
<th>Primary outcome</th>
<th>Results</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lin et al.</td>
<td>66</td>
<td>Hip surgery</td>
<td>PENG vs FNB</td>
<td>PENG: R 0.75% 20 mL, FNB: R 0.75% 20 mL</td>
<td>Pain score</td>
<td>PENG group: less pain in the PACU, better preserved quadriceps strength</td>
<td>Reduced/absent quadriceps strength in 33% in the PENG group vs 77% in FNB group</td>
</tr>
<tr>
<td>Sahoo et al.</td>
<td>20</td>
<td>Analgesia for hip fracture</td>
<td>PENG</td>
<td>B 0.25% 20 mL w/ 4 mg dexamethasone</td>
<td>Pain control and ease of sitting for SAB</td>
<td>Pain score at rest &lt;3/10; in 80%, mild pain with movement. Optimal sitting in 75%.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Remily et al.</td>
<td>96</td>
<td>THA</td>
<td>SAB + FIB + PENG</td>
<td>PENG: B 0.5% 10 mL w/ 1:400,000 epinephrine, FIB: B 0.5% 30 mL w/ 1:200,000 epinephrine</td>
<td>Patient outcome, pain score and opioid consumption</td>
<td>Shorter LOS, farther initial distance walked, lower pain scores until the 48-hour mark, longer time to first opioid, less opioid on day 1, 2 and cumulatively over the entire stay</td>
<td>Not reported</td>
</tr>
<tr>
<td>Kukreja et al.</td>
<td>16</td>
<td>Revision THA</td>
<td>PENG + QLB vs QLB</td>
<td>PENG: R 0.5% 20 mL, QLB: B 0.25% 25 mL</td>
<td>Pain score and opioid consumption</td>
<td>PENG + QLB group: lower pain at 6 h and 24 h and lower opioid use until 12 h</td>
<td>Not reported</td>
</tr>
<tr>
<td>Mysore et al.</td>
<td>123</td>
<td>THA</td>
<td>PENG + LIA vs. LIA</td>
<td>PENG: B 0.25% 20 mL w/ 1:200,000 epinephrine and 2 mg dexamethasone, LIA: B 0.25% 20-40 mL w/ epinephrine</td>
<td>Opioid consumption</td>
<td>PENG block + LIA group: reduction in the mean 24 h postoperative opioid consumption</td>
<td>Not reported</td>
</tr>
</tbody>
</table>


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Table 2. Reported cases of PENG block single-shot for acute pain management

<table>
<thead>
<tr>
<th>N</th>
<th>Procedure</th>
<th>LA</th>
<th>Additional RA interventions and LA</th>
<th>Results</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Analgesis for hip fracture</td>
<td>B 0.25% 20 mL w/ 1:400,000 epinephrine or R 0.5% 20 mL w/ 1:200,000 epinephrine and 4 mg dexamethasone</td>
<td>None</td>
<td>All patients could flex the hip and perform a straight leg raise to 15° and reported significantly reduced pain scores at 30 minutes. No quadriceps weakness.</td>
<td>Not reported</td>
</tr>
<tr>
<td>3</td>
<td>Analgesis for hip fracture</td>
<td>B 0.5% w/ epinephrine 20 mL + normal saline 10 mL</td>
<td>None</td>
<td>Effective analgesia within 30 minutes. Restored ability to range the hip with minimal/no pain.</td>
<td>Not reported</td>
</tr>
<tr>
<td>10</td>
<td>Analgesis for hip fracture</td>
<td>B 0.125% 20 mL w/ 4 mg dexamethasone</td>
<td>None</td>
<td>Lower pain score: 1.3-10/10 at 10 minutes. 9 patients were able to self-position for sitting SAB.</td>
<td>Not reported</td>
</tr>
<tr>
<td>10</td>
<td>Hip surgery</td>
<td>LA not specified</td>
<td>LFCN block (LA not specified)</td>
<td>In the group without LFCN block, &quot;a few patients&quot; required rescue opioids for dermatomal pain. Authors describe a combination of the PENG block with LFCN block to provide better analgesia than the PENG block alone.</td>
<td>Not reported</td>
</tr>
<tr>
<td>12</td>
<td>THA</td>
<td>R 0.5% 20 mL</td>
<td>None</td>
<td>Postoperative pain scores and OME lower in the group undergoing primary THA compared to revisions.</td>
<td>Not reported</td>
</tr>
<tr>
<td>3</td>
<td>THA</td>
<td>B 0.5% 10 mL + L 2% 10 mL</td>
<td>LESP block: B 0.25% 30 mL</td>
<td>No pain in the incision site and in the sensory areas of the FN, LFCN and ON at 1h. Pain score &lt;3/10 for 24 h. 6-8 mg IV morphine equivalent consumption.</td>
<td>Not reported</td>
</tr>
<tr>
<td>4</td>
<td>THA</td>
<td>LB 0.375% 20 mL w/ 4 mg dexamethasone</td>
<td>LIA: LB 0.375% 20 mL, 30 mg ketorolac and 0.1 mg epinephrine</td>
<td>Postoperative pain at rest was &quot;two controls&quot; and with movement was &quot;four controls&quot; during 24h. No additional analgesics needed.</td>
<td>Not reported</td>
</tr>
<tr>
<td>10</td>
<td>THA</td>
<td>LB 0.25% 40 mL w/ 4 mg dexamethasone</td>
<td>LIA: LB 0.25% 80 mL, 30 mg ketorolac, 0.1 mg epinephrine, 10 mg morphine</td>
<td>Surgical incision: M 1% 10 mL Postoperative pain score &lt;4/10. No postoperative opioids required.</td>
<td>Not reported</td>
</tr>
<tr>
<td>5</td>
<td>Analgesis for hip fracture</td>
<td>Not specified</td>
<td>None</td>
<td>All patients reported significant dynamic pain relief in 15 minutes. No quadriceps weakness.</td>
<td>Not reported</td>
</tr>
<tr>
<td>5</td>
<td>Hip arthroscopy</td>
<td>B 0.75% 10 mL + L 1% 10 mL</td>
<td>FNIB: B 0.75% 10 mL + L 1% 10 mL</td>
<td>No motor block of the FN or ON. Need for IV morphine in first 24 hours (3-6 mg) in 2 cases.</td>
<td>Not reported</td>
</tr>
<tr>
<td>2</td>
<td>TURBT</td>
<td>B 0.5% 15 mL + L 2% 15 mL</td>
<td>None</td>
<td>No adductor muscle spasm. Loss of sensation of ON, FN, LFCN and genitofemoral nerve.</td>
<td>Not reported</td>
</tr>
<tr>
<td>2</td>
<td>Vein ligation and stripping</td>
<td>B 0.5% 15 mL + L 2% 15 mL</td>
<td>None</td>
<td>Surgery tolerated with a maximum of 2 mg/kg/h propofol. No opioids required.</td>
<td>Not reported</td>
</tr>
<tr>
<td>15</td>
<td>Open reduction</td>
<td>B 0.25% 10 mL</td>
<td>None</td>
<td>Need for single-dose Ibuprofen 10h postoperatively. No additional analgesia required for 24h.</td>
<td>Not reported</td>
</tr>
<tr>
<td>1</td>
<td>THA</td>
<td>LB 0.375% 15 mL</td>
<td>None</td>
<td>No additional analgesics required during the perioperative period.</td>
<td>Not reported</td>
</tr>
<tr>
<td>2</td>
<td>Vein ligation and stripping</td>
<td>B 0.35% 15 mL + L 2% 15 mL</td>
<td>None</td>
<td>Sensory loss of LFCN, genitofemoral, anterior femoral cutaneous, ON, and saphenous nerves. No need for additional analgesics. Lower pain score: 1/10 at 10 minutes and 2/10 with positioning (hip fracture case).</td>
<td>Not reported</td>
</tr>
<tr>
<td>1</td>
<td>THA</td>
<td>B 0.25% 30 mL</td>
<td>LFCN block: B 0.25% 5 mL</td>
<td>Pain score 0/24 h &lt;3/10 and 48-72 h &lt;1/10. No opioids required.</td>
<td>Not reported</td>
</tr>
<tr>
<td>1</td>
<td>Analgesis for hip fracture</td>
<td>LB 0.375% 20 mL w/ 4 mg dexamethasone</td>
<td>None</td>
<td>Lower pain score: 0/10. No opioids required over 24h and the patient was able to ambulate. After block dissipation, the pain score 0-2/10 with oral medication (11 mg IV morphine equivalent). Discharged at 48h.</td>
<td>Not reported</td>
</tr>
<tr>
<td>1</td>
<td>Hip surgery</td>
<td>LB 0.375% 15 mL</td>
<td>None</td>
<td>No additional analgesics required during the perioperative period.</td>
<td>Not reported</td>
</tr>
<tr>
<td>1</td>
<td>Analgesis for hip fracture</td>
<td>LB 0.25% 30 mL</td>
<td>LFCN block: B 0.25% 5 mL</td>
<td>Pain score 0/24 h during 24 h, 2/10 at rest and 3/10 with movement at 24-48 h. No additional analgesics.</td>
<td>Not reported</td>
</tr>
<tr>
<td>1</td>
<td>Analgesis for hip fracture</td>
<td>LB 0.375% 20 mL w/ 4 mg dexamethasone</td>
<td>None</td>
<td>Lower pain score: 1/10 with passive mobilization and 4/10 at rest in the lying position at 24h. No need for analgesic for 12h.</td>
<td>Not reported</td>
</tr>
<tr>
<td>2</td>
<td>Hip surgery</td>
<td>B 0.25% 30 mL</td>
<td>None</td>
<td>Postoperative pain score &lt;3/10 during 24h. No rescue analgesia.</td>
<td>Not reported</td>
</tr>
<tr>
<td>2</td>
<td>THA</td>
<td>B 0.25% or 0.5% 20 mL w/ 50 mcg/mL dexamethasone and 1:400,000 epinephrine</td>
<td>None</td>
<td>Postoperative opioids required. Decreased sensation over the distal half of the thigh, knee and saphenous nerve distribution below the knee.</td>
<td>Not reported</td>
</tr>
<tr>
<td>1</td>
<td>Femoral osteosynthetic material removal</td>
<td>B 0.5% 10 mL w/ epinephrine</td>
<td>FNIB: B 1.1% 7.5 mL + LB 0.75% 7.5 mL LFCN block: B 1.1% 2.5 mL 1% L + LB 0.75% 2.5 mL</td>
<td>Pain score &lt;2/10 for 72h. No additional analgesia required.</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

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Ahiskalioglu et al. \cite{28}

| 1 | Medial thigh mass removal | B 0.5% 15 mL + L 2% 15 mL | None | Sensory loss of the FN, ON and LFCN dermatomes at 5 minutes. No intraoperative additional opioids and sedatives required besides 1 mg midazolam. Discharge on the same day. | Not reported |

Talawar et al. \cite{29}

| 1 | Hip arthroscopy | B 0.5% 10 mL + L 2% 10 mL w/ epinephrine | LFCN block: B 0.5% 5 mL + L 2% 5 mL w/ epinephrine | Sensory loss of the anterior, medial, and lateral thigh at 20 minutes. Analgesia lasted for 4.30 h postoperatively. | Not reported |

Oksüz et al. \cite{36}

| 1 | Distal tibia and fibula fracture surgery | B 0.25% 25 ml + L 2% 10 ml | Subgluteal block: B 0.25% 15 ml | Adequate anesthesia of FN, ON, LFCN and SN upon evaluation at 30 min. 2 h surgery and no surgical or tourniquet pain. | Not reported |


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<table>
<thead>
<tr>
<th>N</th>
<th>Procedure</th>
<th>LA</th>
<th>Catheter infusion</th>
<th>Results</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Del Buono et al. 17</td>
<td>Hip surgery</td>
<td>R 0.375% or L 0.5% 20 mL</td>
<td>Not specified. Stopped at 72 h</td>
<td>Lower pain score: 2/10 at 20 minutes. 2/10 median pain score after 12, 24, and 48 h. No rescue medication needed.</td>
<td>3 cases of IV catheter placement</td>
</tr>
<tr>
<td>Singh et al. 18</td>
<td>Hip surgery</td>
<td>B 0.25% 20 mL</td>
<td>B 0.25% at 5 ml/h at the end of the surgery. Stopped on day 2</td>
<td>Lower pain score: 1-3/10 at 30 minutes, &lt;2/10 at 6 h and &lt;1/10 at 48 h. No additional analgesics required intraoperatively or postoperatively.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Singh et al. 32</td>
<td>THA</td>
<td>B 0.5% 15 mL</td>
<td>B 0.5% at 5 ml/h at the beginning of the surgery, continued at the end of the surgery w/ B 0.125% at 5 mL/h. Stopped on day 3</td>
<td>Sensory loss of the FN, ON, LFCN, and genitofemoral nerve at 30 minutes. Pain score always &lt;3/10, not requiring additional analgesia.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Wyatt et al. 34</td>
<td>Analgesia for hip fracture</td>
<td>B 0.25% 14 mL</td>
<td>R 0.1% at 6 ml/h at the end of the surgery. Stopped at 24 h</td>
<td>Pain score of 2-3/10 after surgery, pre-infusion. No motor weakness. FLACC 0 at 12 h.</td>
<td>Not reported</td>
</tr>
<tr>
<td>Fujino et al. 25</td>
<td>THA</td>
<td>R 0.5% 20 mL</td>
<td>R 0.2% at 6 ml/h before the end of the surgery. Stopped at 48 h</td>
<td>Pain score of 0/10 at rest and ≤3/10 at movement during first 48 h. Bromage scale 0.</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

Table 4. Reported cases of PENG block for chronic pain management

<table>
<thead>
<tr>
<th>N</th>
<th>Procedure</th>
<th>Neurolytic PENG block</th>
<th>Results</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Refractory pain (hip osteoarthritis)</td>
<td>Bipolar RF ablation 60 seconds at 80 degrees once at 2 to 3 different locations using a 4-output RF generator</td>
<td>Pain score decreased from 10/10 and 7/10 to 0–1/10 at 3 months. No need for opioid analgesia and subjective improvement in the quality of life. Repeated in 9 months in one patient due to pain recurrence.</td>
<td>Not reported</td>
</tr>
<tr>
<td>1</td>
<td>Analgesia for hip fracture (metastatic carcinoma)</td>
<td>6% phenol 10 mL</td>
<td>Pain score pre-block of 8/10. Complete pain relief at 30 minutes, maintained at 2 weeks. No motor block.</td>
<td>Not reported</td>
</tr>
<tr>
<td>1</td>
<td>Analgesia for hip metastasis of gastric cancer</td>
<td>5% phenol 4 mL</td>
<td>Severe refractory pain pre-block (10/10). 90% pain relief until patient’s death (10 days later).</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

PENG: pericapsular nerve group, RF: radiofrequency.
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