

Review Article

Research Progress on Postoperative Analgesia After Total Hip Arthroplasty

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Abstract

Total hip arthroplasty (THA) is a highly effective treatment for end-stage osteoarthritis and hip fractures, significantly enhancing patients' quality of life. However, substantial postoperative pain remains a challenge, potentially impeding rehabilitation, prolonging hospitalization, and increasing the risk of chronic pain and subsequent revision surgeries. Multimodal analgesia (MA), which combines two or more analgesic methods with different mechanisms, is commonly employed in clinical practice to manage postoperative pain in THA. Among these methods, regional nerve blocks and local infiltration analgesia (LIA) have gained increasing attention due to their excellent analgesic effects and relatively few adverse reactions. This article reviews the two primary analgesic methods for postoperative THA: regional nerve blocks, including the emerging pericapsular nerve group block (PENG block), and LIA. Regional nerve blocks, such as femoral nerve block (FNB) and PENG block, have demonstrated efficacy in reducing postoperative pain and opioid consumption while preserving quadriceps muscle strength, thereby promoting rapid postoperative recovery. The PENG block, in particular, has shown promise as a preferred nerve block option for THA due to its ability to effectively block multiple nerves supplying the hip joint without affecting lower limb muscle strength. LIA, involving the infiltration of a high-volume local anesthetic solution around the joint capsule and surgical incision, has also proven to be a simple, cost-effective, and efficacious method for acute pain control after THA. Its analgesic effects are comparable to those of intrathecal morphine injection or peripheral nerve blocks, and it does not affect lower limb muscle strength. Combining LIA with nerve blocks such as PENG and FNB can further enhance multimodal analgesia. However, there is currently no unified formula for the drug composition of LIA, and research on liposomal bupivacaine, a sustained-release formulation of bupivacaine, has yielded varying results regarding its benefits. Overall, current evidence supports the use of regional nerve blocks, particularly the PENG block, and LIA as effective analgesic methods for postoperative THA, with the potential for further optimization through combination therapies and standardized protocols.

Keywords

Total Hip Arthroplasty, Multimodal Analgesia, Regional Nerve Block, Local Infiltration Anesthesia

1. Introduction

Total hip arthroplasty (THA) is considered the most efficacious intervention for end-stage osteoarthritis, hip fractures, and related conditions, substantially improving patients'

quality of life. Nonetheless, a considerable number of patients encounter substantial postoperative pain, impeding rehabilitation, extending hospitalization, and potentially resulting in

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chronic pain. This enduring pain can detrimentally impact patients' psychological well-being and elevate the likelihood of hip joint revision surgeries [1, 2]. Currently, in clinical practice, THA commonly employs multimodal analgesia (MA) involving two or more analgesic methods with different mechanisms [3]. Among these, regional nerve blocks have gradually emerged as one of the effective strategies for postoperative pain management, reducing the use of opioid drugs and their associated adverse effects, enhancing analgesic efficacy, improving patient satisfaction after surgery, and enhancing quality of life [4, 5]. The multimodal analgesia regimens for postoperative THA include patient-controlled intravenous analgesia (PCIA), neuraxial anesthesia (such as spinal or epidural anesthesia), regional nerve block anesthesia, and local infiltration anesthesia (LIA) [5]. Due to their excellent analgesic effects and relatively few adverse reactions in recent years, regional nerve block anesthesia and LIA have garnered increasing attention and have become favorable options for perioperative analgesia in THA [6]. This article provides a review of the two primary analgesic methods currently employed for postoperative THA: regional nerve blocks and LIA, aiming to offer references and insights for clinical postoperative analgesia in THA.

2. Regional Nerve Block

The femoral nerve, obturator nerve, and accessory obturator nerve are responsible for innervating the anterior capsule of the hip joint. Meanwhile, the sciatic nerve, quadratus femoris nerve, superior gluteal nerve, and inferior gluteal nerve play a role in innervating the posterior capsule of the hip joint. In addition, the blockade of the lateral femoral cutaneous nerve is frequently employed to provide sensory coverage for the skin incision during hip joint surgery [7]. Common peripheral nerve blocks include femoral nerve block (FNB), fascia iliaca compartment block (FICB), and lumbar plexus block (LPB). However, none of these can completely block all the nerves supplying the hip joint, and they may also cause a decrease in postoperative quadriceps muscle strength, increasing the risk of postoperative falls in patients [8]. In 2018, Girón-Arango L et al. proposed that the pericapsular nerve group block (PENG block) not only reduces postoperative pain after THA but also does not affect lower limb muscle strength, thereby promoting rapid postoperative recovery in patients [9]. As a new postoperative analgesic method for THA, it has received widespread attention.

The target location for the PENG block is near the shallow groove between the anterior inferior iliac spine (AIIS), the superior pubic ramus, and the iliopubic eminence (IPE). The iliopsoas tendon (IPT) passes above this groove, traverses the hip joint, and enters the lesser trochanter of the femur [10, 11]. This is also an important anatomical advantage that enables the PENG block to effectively block the femoral nerve, obturator nerve, and accessory obturator nerve.

Kukreja P et al. conducted a single-blind, randomized con-

trolled, single-center study on 112 patients to compare the effects of PENG block versus no PENG block during the first THA under neuraxial anesthesia [10]. The results showed that compared with no block, PENG block could improve the Quality of Recovery-15 (QOR-15) scale score at 48 hours postoperatively and reduce the demand for opioids at 48 hours postoperatively. However, there were no statistically significant differences in postoperative pain scores or walking distance. Lin X et al. studied 60 patients and found that compared with no block, PENG block could relieve the numerical rating scale (NRS) pain score during activity in patients with hip fractures and reduce opioid use within 24 hours [12]. PENG block also demonstrated good efficacy compared with other nerve blocks. Lin DY et al. studied 60 patients and reported that compared with FNB, PENG block could reduce the pain score during the observation period in the post-anesthesia care unit (PACU), although it had no significant advantage in reducing long-term postoperative pain scores [13]. However, PENG block could better preserve quadriceps muscle strength postoperatively and reduce the risk of falls. Jeevendiran A et al. showed that PENG block significantly relieved postoperative pain, had no adverse reactions, and improved patient satisfaction, providing an effective analgesic option for patients with hip fractures [14]. The study also found that PENG block combined with lateral femoral cutaneous nerve block (LFCN block) could promote earlier ambulation in patients compared with FICB, result in greater hip flexion range of motion postoperatively, and higher muscle strength on the affected side, thereby facilitating Enhanced Recovery After Surgery (ERAS) [14]. Duan L et al. compared the effects of continuous PENG block and continuous FICB and found that continuous PENG block had superior postoperative analgesic effects and could promote the recovery of quadriceps muscle strength [15]. Marrone F et al. included 60 elderly patients with proximal femoral fractures and found that 30 minutes after surgery, the proportion of patients with an NRS score less than 4 was 53.3% in the PENG block group and 53.6% in the FICB group, the results indicated that PENG block did not provide superior postoperative analgesia compared with FICB [16]. Braun AS et al. showed that both PENG block and quadratus lumborum block (QLB) reduced the cumulative oral morphine equivalent dose postoperatively, and the postoperative Visual Analog Scale (VAS) scores were comparable; PENG block did not provide better pain relief than QLB [17].

Although the analgesic efficacy of the PENG block compared to other nerve block techniques remains a subject of debate, current evidence supports its consideration as a preferred nerve block option for THA. The PENG block is associated with reduced postoperative analgesic requirements, preserved quadriceps muscle strength, improved hip flexion mobility, and increased patient satisfaction during hospitalization.

3. Local Infiltration Analgesia (LIA)

LIA is an analgesic technique that involves the use of a

high-volume local anesthetic solution containing adjuvants (such as epinephrine, ketorolac, opioids, steroids, etc.). The surgeon administers this analgesic solution by infiltrating it layer by layer around the joint capsule and the surgical incision after prosthesis placement and suture of the joint capsule. LIA is a simple and cost-effective method that does not affect lower limb muscle strength. Its analgesic efficacy is not inferior to that of intrathecal morphine injection or peripheral nerve blocks, and it has emerged as an alternative technique for acute pain control after total knee arthroplasty (TKA) [18, 19].

Multiple randomized trials comparing LIA with saline, or no injection have consistently demonstrated its favorable analgesic effects in the early postoperative period (0-24 hours) [20-22]. When LIA is used as part of a multimodal analgesia regimen in combination with acetaminophen, celecoxib, and gabapentin, no statistically significant differences in pain scores or opioid requirements have been observed compared to regimens without LIA [18]. A meta-analysis including 38 randomized controlled trials showed that the LIA group had lower pain scores, reduced opioid consumption, and fewer instances of postoperative nausea and vomiting compared to the non-LIA group, indicating that LIA is effective for acute pain management after TKA, and intraoperative periarticular injection may contribute to pain control for up to 24 hours [23]. Another meta-analysis involving 13 studies, and 909 patients also found that patients receiving LIA had lower pain scores at rest at 24 and 48 hours postoperatively compared to the control group [24].

Some studies have compared LIA with other analgesic modalities. A study comparing the analgesic effects of PENG block combined with LIA versus LIA alone found that the combination reduced intraoperative and postoperative opioid consumption, prolonged the time to the first rescue analgesic, and decreased pain at rest and during hip flexion activities within the first 24 hours postoperatively, while preserving quadriceps muscle strength and promoting early patient rehabilitation [25]. In one trial, compared to continuous femoral nerve block (cFNB), LIA provided better analgesia only on the second postoperative day, with lower pain scores and reduced opioid requirements in the first 32 hours postoperatively [26]. Affas et al. reported that LIA and femoral nerve block (FNB) had similar analgesic effects in the first 24 hours postoperatively [27]. Koh et al. randomized trial compared LIA plus cFNB with cFNB alone and found that LIA reduced pain in the first 48 hours postoperatively and decreased opioid requirements in the first 24 hours postoperatively [28]. The differences in these study results may be attributed to the varying nerve block techniques used in each study. A non-blinded, randomized clinical trial involving 75 patients compared LIA with continuous epidural analgesia and found that LIA reduced pain from 20 to 96 hours postoperatively and decreased opioid requirements from 8 to 96 hours postoperatively [29]. Spreng et al.'s trial showed that compared to continuous epidural analgesia, the LIA group experienced in-

creased pain on the day of surgery but had reduced pain and opioid requirements from postoperative days 1 to 3 [30].

Furthermore, compared to systemic administration of non-steroidal anti-inflammatory drugs (NSAIDs), LIA with local infiltration of NSAIDs provided an analgesic effect of 5 - 10 mm on the VAS [31]. Only the experiment by Parvataneni et al. included 71 patients who underwent LIA for THA using bupivacaine, morphine, epinephrine, prednisolone, and antibiotics, and patients receiving patient-controlled analgesia with opioids. In this trial, patients receiving LIA reported reduced pain and shorter hospital stays from postoperative days 1 to 3 [32]. However, this trial also had a high risk of bias. Only one randomized controlled trial involving 60 patients compared LIA with intrathecal morphine injection and found that the two groups had similar pain scores in the first 48 hours postoperatively, but the LIA group had increased opioid requirements [33].

In general, current research supports the favorable local analgesic effects of LIA, and its combination with nerve blocks such as PENG block and FNB can better achieve multimodal analgesia [18]. Currently, there is no unified formula for the drug composition of LIA. Commonly used drugs include various local anesthetics such as bupivacaine and ropivacaine, combined with combinations of NSAIDs, steroids, opioids, and epinephrine [18]. Research has mainly focused on the efficacy of liposomal bupivacaine (LB). Bupivacaine is one of the most widely used local anesthetics. Compared to bupivacaine hydrochloride, LB provides sustained release of bupivacaine, with analgesia lasting up to 72 hours. It has been approved by the U.S. Food and Drug Administration (FDA) for use in LIA [34]. Previously published meta-analyses have shown that LB provides superior perioperative analgesia compared to traditional LIA using ropivacaine [35]. Previous clinical trials have also demonstrated that LB can reduce pain scores at 12, 24, 48, and 72 hours postoperatively [36, 37]. A retrospective cohort study also found that local infiltration of LB reduced the use of opioids and antiemetics within the first 24 hours postoperatively [38]. However, the benefits of LB remain controversial. A systematic review including 17 randomized controlled trials on TKA found no difference in pain scores between LB and bupivacaine [39]. Two large sample randomized controlled trials reported that LB did not improve postoperative pain in patients [40, 41]. Conversely, Bagsby et al. found that patients in the LB group reported higher pain scores than those in the traditional LIA group after the first 24 hours [42]. Nevertheless, the mechanism of LB is relatively slow, and more attention should be paid to its analgesic effects 24 hours postoperatively [43]. Nasir et al. compared the LB group with the control group and found no difference in the area under the pain curve on postoperative day 2. No additional analgesic, functional, or safety advantages were observed with LB on postoperative day 2 or 3 [43]. The varying results may be due to differences in the adjuvant drugs used in local infiltration and the con-

centrations of the drugs. Additionally, the use of adjuvant analgesics in the control group may have masked any differences.

Table 1. Summary of the main studies on LIA and regional nerve block after THA surgery.

Group	Local anesthetic concentration and volume (PENG block)	Primary outcome
PENG group (n=56) Placebo group (n=56) [10]	0.5% bupivacaine 25 ml	The QOR-15 scale in 24 hours after surgery
PENG +LIA (n=34) LIA (n=36) [44]	0.5% ropivacaine 20 ml	The highest VAS score during PACU
PENG +LIA (n=30) LIA (n=30) [45]	0.375% ropivacaine 20 ml	The highest NRS score in 48 hours after surgery
PENG+ LFCN (n=46) FICB (n=46) [46]	0.33% ropivacaine 20 ml	The time of the first postoperative walking
PENG (n=30) FICB (n=22) [47]	0.5% ropivacaine 3 ml/kg (Maximum dosage: 40 ml)	VAS score
PENG (n=30) FNB (n=30) [12]	0.75% ropivacaine 20 ml	The NRS score in 4 hours after surgery
Continuous PENG+LIA (n=29) Continuous FICB+LIA (n=28) [15]	0.25% ropivacaine 30 ml	NRS score after surgery
PENG (n=27) FICB (n=27) [44]	0.25% ropivacaine 20 ml + 1:200,000 epinephrine	NRS score after surgery

4. Conclusions

At present, regional nerve blocks or LIA are recommended for postoperative analgesia in elderly patients undergoing THA, as these techniques have demonstrated efficacy in reducing adverse events. Table 1 provides a summary of the current literature regarding the use of PENG block and LIA. Furthermore, when clinically appropriate, integrating nerve blocks into a multimodal analgesia strategy represents a practical and effective approach. Currently, no studies have determined which nerve block (FNB or PENG), when combined with LIA, produces superior outcomes. Future research could focus on exploring this aspect. Additionally, substantial heterogeneity exists in LIA protocols and local anesthetic concentrations among studies, limiting the ability to define a standardized and optimal analgesic regimen. Future research should focus on addressing this variability and identifying the most efficacious LIA protocol.

Abbreviations

THA Total Hip Arthroplasty

MA	Multimodal Analgesia
LIA	Local Infiltration Anesthesia
PENG Block	Pericapsular Nerve Group Block
FNB	Femoral Nerve Block
PCIA	Patient-Controlled Intravenous Analgesia
FICB	Fascia Iliaca Compartment Block
LPB	Lumbar Plexus Block
AIIS	Anterior Inferior Iliac Spine
IPE	Iliopubic Eminence
IPT	Iliopsoas Tendon
QOR-15	Quality of Recovery-15
NRS	Numerical Rating Scale
PACU	Post-Anesthesia Care Unit
LFCN Block	Lateral Femoral Cutaneous Nerve Block
ERAS	Enhanced Recovery After Surgery
QLB	Quadratus Lumborum Block
VAS	Visual Analog Scale
TKA	Total Knee Arthroplasty
cFNB	Continuous Femoral Nerve Block
NSAIDs	Nonsteroidal Anti-Inflammatory Drugs
LB	Liposomal Bupivacaine
FDA	Food and Drug Administration

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Min BW, Kim Y, Cho HM, et al. Perioperative Pain Management in Total Hip Arthroplasty: Korean Hip Society Guidelines. *Hip & pelvis*, 2016, 28(1): 15-23. <https://doi.org/10.5371/hp.2016.28.1.15>
- [2] Fischer HB, Simanski CJ. A procedure-specific systematic review and consensus recommendations for analgesia after total hip replacement. *Anaesthesia*, 2005, 60(12): 1189-202. <https://doi.org/10.1111/j.1365-2044.2005.04382.x>
- [3] Oshodi TO. The impact of preoperative education on postoperative pain. Part 1. *British journal of nursing* (Mark Allen Publishing), 2007, 16(12): 706-10. <https://doi.org/10.12968/bjon.2007.16.12.23719>
- [4] Lundblad H, Kreicbergs A, Jansson KA. Prediction of persistent pain after total knee replacement for osteoarthritis. *The Journal of bone and joint surgery British volume*, 2008, 90(2): 166-71. <https://doi.org/10.1302/0301-620X.90B2.19640>
- [5] Johnson RL, Kopp SL. Optimizing perioperative management of total joint arthroplasty. *Anesthesiology clinics*, 2014, 32(4): 865-80. <https://doi.org/10.1016/j.anclin.2014.08.006>
- [6] Memtsoudis SG, Cozowicz C, Bekeris J, et al. Peripheral nerve block anesthesia/analgesia for patients undergoing primary hip and knee arthroplasty: recommendations from the International Consensus on Anesthesia-Related Outcomes after Surgery (ICAROS) group based on a systematic review and meta-analysis of current literature. *Regional anesthesia and pain medicine*, 2021, 46(11): 971-85. <https://doi.org/10.1136/rapm-2021-102750>
- [7] Scala VA, Lee LSK, Atkinson RE. Implementing Regional Nerve Blocks in Hip Fracture Programs: A Review of Regional Nerve Blocks, Protocols in the Literature, and the Current Protocol at The Queen's Medical Center in Honolulu, HI. *Hawai'i journal of health & social welfare*, 2019, 78(11 Suppl 2): 11-5.
- [8] Acharya U, Lamsal R. Pericapsular Nerve Group Block: An Excellent Option for Analgesia for Positional Pain in Hip Fractures. *Case reports in anesthesiology*, 2020, 2020: 1830136. <https://doi.org/10.1155/2020/1830136>
- [9] Girón-Arango L, Peng PWH, Chin KJ, et al. Pericapsular Nerve Group (PENG) Block for Hip Fracture. *Regional anesthesia and pain medicine*, 2018, 43(8): 859-63. <https://doi.org/10.1097/AAP.0000000000000847>
- [10] Kukreja P, Uppal V, Kofskey AM, et al. Quality of recovery after pericapsular nerve group (PENG) block for primary total hip arthroplasty under spinal anaesthesia: a randomised controlled observer-blinded trial. *British journal of anaesthesia*, 2023, 130(6): 773-9. <https://doi.org/10.1016/j.bja.2023.02.017>
- [11] Jiang, J., Liang, J., & Ma, D. Pericapsular nerve group (PENG) block as an effective technique for iliopsoas tendon injury. *Minerva anesthesiologica*. 2023, 89(9), 839–841. <https://doi.org/10.23736/S0375-9393.23.17290-7>
- [12] Lin X, Liu CW, Goh QY, et al. Pericapsular nerve group (PENG) block for early pain management of elderly patients with hip fracture: a single-center double-blind randomized controlled trial. *Regional anesthesia and pain medicine*, 2023, 48(11): 535-9. <https://doi.org/10.1136/rapm-2022-104117>
- [13] Lin DY, Morrison C, Brown B, et al. Pericapsular nerve group (PENG) block provides improved short-term analgesia compared with the femoral nerve block in hip fracture surgery: a single-center double-blinded randomized comparative trial. *Regional anesthesia and pain medicine*, 2021, 46(5): 398-403. <https://doi.org/10.1136/rapm-2020-102315>
- [14] Jeevendiran A, Suganya S, Sujatha C, et al. Comparative Evaluation of Analgesic Efficacy of Ultrasound-Guided Pericapsular Nerve Group Block and Femoral Nerve Block During Positioning of Patients With Hip Fractures for Spinal Anesthesia: A Prospective, Double-Blind, Randomized Controlled Study. *Cureus*, 2024, 16(3): e56270. <https://doi.org/10.7759/cureus.56270>
- [15] Duan L, Zhang L, Shi CG, et al. Comparison of continuous pericapsular nerve group (PENG) block versus continuous fascia iliaca compartment block on pain management and quadriceps muscle strength after total hip arthroplasty: a prospective, randomized controlled study. *BMC anesthesiology*, 2023, 23(1): 233. <https://doi.org/10.1186/s12871-023-02190-1>
- [16] Marrone F, Graziano G, Paventi S, et al. Analgesic efficacy of Pericapsular Nerve Group (PENG) block compared with Fascia Iliaca Block (FIB) in the elderly patient with fracture of the proximal femur in the emergency room. A randomised controlled trial. *Rev Esp Anesthesiol Reanim (Engl Ed)*. 2023, 70(9): 501-508. <https://doi.org/10.1016/j.redare.2022.10.010>
- [17] Braun AS, Peabody Lever JE, Kalagara H, et al. Comparison of Pericapsular Nerve Group (PENG) Block Versus Quadratus Lumborum (QL) Block for Analgesia After Primary Total Hip Arthroplasty Under Spinal Anesthesia: A Retrospective Study. *Cureus*, 2023, 15(12): e50119. <https://doi.org/10.7759/cureus.50119>
- [18] Andersen L, Kehlet H. Analgesic efficacy of local infiltration analgesia in hip and knee arthroplasty: a systematic review. *British journal of anaesthesia*, 2014, 113(3): 360-74. <https://doi.org/10.1093/bja/aeu155>
- [19] Jiménez-Almonte JH, Wyles CC, Wyles SP, et al. Is Local Infiltration Analgesia Superior to Peripheral Nerve Blockade for Pain Management After THA: A Network Meta-analysis. *Clinical orthopaedics and related research*, 2016, 474(2): 495-516. <https://doi.org/10.1007/s11999-015-4619-9>
- [20] Andersen LJ, Poulsen T, Krogh B, et al. Postoperative analgesia in total hip arthroplasty: a randomized double-blinded, placebo-controlled study on peroperative and postoperative ropivacaine, ketorolac, and adrenaline wound infiltration. *Acta orthopaedica*, 2007, 78(2): 187-92. <https://doi.org/10.1080/17453670710013663>

- [21] Busch CA, Whitehouse MR, Shore BJ, et al. The efficacy of periarticular multimodal drug infiltration in total hip arthroplasty. *Clinical orthopaedics and related research*, 2010, 468(8): 2152-9. <https://doi.org/10.1007/s11999-009-1198-7>
- [22] Dobie I, Bennett D, Spence DJ, et al. Periarticular local anesthesia does not improve pain or mobility after THA. *Clinical orthopaedics and related research*, 2012, 470(7): 1958-65. <https://doi.org/10.1007/s11999-012-2241-7>
- [23] Seangleulur A, Vanasbodeekul P, Prapaitrakool S, et al. The efficacy of local infiltration analgesia in the early postoperative period after total knee arthroplasty: A systematic review and meta-analysis. *European journal of anaesthesiology*, 2016, 33(11): 816-31. <https://doi.org/10.1097/EJA.0000000000000516>
- [24] Marques EM, Jones HE, Elvers KT, et al. Local anaesthetic infiltration for peri-operative pain control in total hip and knee replacement: systematic review and meta-analyses of short- and long-term effectiveness. *BMC musculoskeletal disorders*, 2014, 15: 220. <https://doi.org/10.1186/1471-2474-15-220>
- [25] Hu J, Wang Q, Hu J, et al. Efficacy of Ultrasound-Guided Pericapsular Nerve Group (PENG) Block Combined With Local Infiltration Analgesia on Postoperative Pain After Total Hip Arthroplasty: A Prospective, Double-Blind, Randomized Controlled Trial. *The Journal of arthroplasty*, 2023, 38(6): 1096-103. <https://doi.org/10.1016/j.arth.2022.12.023>
- [26] Carli F, Clemente A, Asenjo JF, et al. Analgesia and functional outcome after total knee arthroplasty: periarticular infiltration vs continuous femoral nerve block. *British journal of anaesthesia*, 2010, 105(2): 185-95. <https://doi.org/10.1093/bja/aeq112>
- [27] Affas F, Nygård EB, Stiller CO, et al. Pain control after total knee arthroplasty: a randomized trial comparing local infiltration anesthesia and continuous femoral block. *Acta orthopaedica*, 2011, 82(4): 441-7. <https://doi.org/10.3109/17453674.2011.581264>
- [28] Koh JJ, Kang YG, Chang CB, et al. Does periarticular injection have additional pain relieving effects during contemporary multimodal pain control protocols for TKA?: A randomised, controlled study. *The Knee*, 2012, 19(4): 253-9. <https://doi.org/10.1016/j.knee.2011.03.007>
- [29] Andersen KV, Pfeiffer-Jensen M, Haraldsted V, et al. Reduced hospital stay and narcotic consumption, and improved mobilization with local and intraarticular infiltration after hip arthroplasty: a randomized clinical trial of an intraarticular technique versus epidural infusion in 80 patients. *Acta orthopaedica*, 2007, 78(2): 180-6. <https://doi.org/10.1080/17453670710013654>
- [30] Spreng UJ, Dahl V, Hjal A, et al. High-volume local infiltration analgesia combined with intravenous or local ketorolac+morphine compared with epidural analgesia after total knee arthroplasty. *British journal of anaesthesia*, 2010, 105(5): 675-82. <https://doi.org/10.1093/bja/aeq232>
- [31] Thorsell M, Holst P, Hyldahl HC, et al. Pain control after total knee arthroplasty: a prospective study comparing local infiltration anesthesia and epidural anesthesia. *Orthopedics*, 2010, 33(2): 75-80. <https://doi.org/10.3928/01477447-20100104-13>
- [32] Parvataneni HK, Shah VP, Howard H, et al. Controlling pain after total hip and knee arthroplasty using a multimodal protocol with local periarticular injections: a prospective randomized study. *The Journal of arthroplasty*, 2007, 22(6 Suppl 2): 33-8. <https://doi.org/10.1016/j.arth.2007.03.034>
- [33] Rikalainen-Salmi R, Förster JG, Mäkelä K, et al. Local infiltration analgesia with levobupivacaine compared with intrathecal morphine in total hip arthroplasty patients. *Acta anaesthesiologica Scandinavica*, 2012, 56(6): 695-705. <https://doi.org/10.1111/j.1399-6576.2012.02667.x>
- [34] Soffin EM, Memtsoudis SG. Anesthesia and analgesia for total knee arthroplasty. *Minerva anesthesiologica*, 2018, 84(12): 1406-12. <https://doi.org/10.1111/j.1399-6576.2012.02667.x>
- [35] Singh PM, Borle A, Trikha A, et al. Role of Periarticular Liposomal Bupivacaine Infiltration in Patients Undergoing Total Knee Arthroplasty-A Meta-analysis of Comparative Trials. *The Journal of arthroplasty*, 2017, 32(2): 675-88. <https://doi.org/10.1016/j.arth.2016.09.042>
- [36] Mont MA, Beaver WB, Dysart SH, et al. Local Infiltration Analgesia With Liposomal Bupivacaine Improves Pain Scores and Reduces Opioid Use After Total Knee Arthroplasty: Results of a Randomized Controlled Trial. *The Journal of arthroplasty*, 2018, 33(1): 90-6. <https://doi.org/10.1016/j.arth.2017.07.024>
- [37] Sporer SM, Rogers T. Postoperative Pain Management After Primary Total Knee Arthroplasty: The Value of Liposomal Bupivacaine. *The Journal of arthroplasty*, 2016, 31(11): 2603-7. <https://doi.org/10.1016/j.arth.2016.05.012>
- [38] Ilfeld BM, Eisenach JC, Gabriel RA. Clinical Effectiveness of Liposomal Bupivacaine Administered by Infiltration or Peripheral Nerve Block to Treat Postoperative Pain. *Anesthesiology*, 2021, 134(2): 283-344. <https://doi.org/10.1097/ALN.0000000000003630>
- [39] Wu ZQ, Min JK, Wang D, et al. Liposome bupivacaine for pain control after total knee arthroplasty: a meta-analysis. *Journal of orthopaedic surgery and research*, 2016, 11(1): 84. <https://doi.org/10.1186/s13018-016-0420-z>
- [40] Hamilton T.W, Knight R, Stokes J.R, et al. Efficacy of Liposomal Bupivacaine and Bupivacaine Hydrochloride vs Bupivacaine Hydrochloride Alone as a Periarticular Anesthetic for Patients Undergoing Knee Replacement: A Randomized Clinical Trial. *JAMA surgery*, 2022, 157(6): 481-9. <https://doi.org/10.1001/jamasurg.2022.0713>
- [41] White S, Vaughan C, Raiff D, et al. Impact of liposomal bupivacaine administration on postoperative pain in patients undergoing total knee replacement. *Pharmacotherapy*, 2015, 35(5): 477-81. <https://doi.org/10.1002/phar.1587>
- [42] Bagsby D. T, Ireland P. H, Meneghini R. M. Liposomal bupivacaine versus traditional periarticular injection for pain control after total knee arthroplasty. *The Journal of arthroplasty*, 2014, 29(8): 1687-90. <https://doi.org/10.1016/j.arth.2014.03.034>

- [43] Hussain N, Brull R, Sheehy B.T, et al. The mornings after-periarticular liposomal bupivacaine infiltration does not improve analgesic outcomes beyond 24 hours following total knee arthroplasty: a systematic review and meta-analysis. *Regional anesthesia and pain medicine*, 2021, 46(1): 61-72. <https://doi.org/10.1136/rapm-2020-101995>
- [44] Zheng J, Pan D, Zheng B, et al. Preoperative pericapsular nerve group (PENG) block for total hip arthroplasty: a randomized, placebo-controlled trial. *Regional anesthesia and pain medicine*, 2022, 47(3): 155-60. <https://doi.org/10.1136/rapm-2021-103228>
- [45] 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(11): 1492-8. <https://doi.org/10.1111/anae.15536>
- [46] Liang L, Zhang C, Dai W, et al. Comparison between pericapsular nerve group (PENG) block with lateral femoral cutaneous nerve block and supra-inguinal fascia iliaca compartment block (S-FICB) for total hip arthroplasty: a randomized controlled trial. *Journal of anesthesia*, 2023, 37(4): 503-10. <https://doi.org/10.1007/s00540-023-03192-6>
- [47] Mosaffa F, Taheri M, Manafi Rasi A, et al. Comparison of pericapsular nerve group (PENG) block with fascia iliaca compartment block (FICB) for pain control in hip fractures: A double-blind prospective randomized controlled clinical trial. *Orthopaedics & traumatology, surgery & research: OTSR*, 2022, 108(1): 103135. <https://doi.org/10.1016/j.otsr.2021.103135>

Biography



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