Systematic Review

The Addition of a Pericapsular Nerve Group Block for Postoperative Pain Control Does Not Result in Less Narcotic Use After Hip Arthroscopy: A Systematic Review

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Purpose: To perform a systematic review of clinical studies evaluating the pericapsular nerve group (PENG) block in patients undergoing hip arthroscopy. **Methods:** A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines to identify comparative studies of patients undergoing the PENG block before hip arthroscopy. The search phrase used was *hip arthroscopy pericapsular nerve block*. Patients were evaluated based on analgesic consumption, time to discharge from the postanesthesia care unit (PACU), and pain scores (Numeric Rating Scale and visual analog scale). The Modified Coleman Methodology Score was used to evaluate study methodology quality. **Results:** Five studies (2 Level I, 3 Level III) met inclusion criteria. The 5 studies included the following comparison groups: 0.9% normal saline injection, general anesthesia alone, and general anesthesia with intraoperative pericapsular bupivacaine injection. The 2 randomized controlled trials included in this review reported no significant difference between groups regarding opioid consumption. One of these did not find any statistically significant differences in their secondary outcomes either, including patient satisfaction with analgesia, opioid-related adverse events, or persistent opioid use at 1 week. However, the other 3 studies found significantly lower opioid consumption in patients receiving the PENG block versus the control group intraoperatively, in the PACU, and/or postoperatively. Four studies reported significantly lower pain levels in the PENG block group compared with the control groups, measured differently in each study: 24 hours postoperatively, initial pain score in the PACU, mean score in the PACU, and highest score in the PACU. None of the studies found significantly worse outcomes in the PENG block group compared to the comparison group. **Conclusions:** Systematic review of randomized controlled trials shows that patients undergoing hip arthroscopy who receive a PENG block do not consume fewer opioids for postoperative pain control than patients who do not receive the block. **Level of Evidence:** Level III, systematic review of Level I-III studies.

The incidence of hip arthroscopy is increasing, and the number of cases in the United States doubled from 2010 to 2014.[1] Postoperative pain control may include oral medications such as nonsteroidal anti-inflammatory drugs and opioids, as well as local injections by the surgeon. Patients are more likely to require additional prescriptions if they were using narcotics preoperatively.[2] Nerve blocks may be a valuable addition to the management of postoperative pain by both reducing pain and contributing to lower postoperative pain medication requirements.[3]

Current analgesic modalities for postoperative pain control following hip arthroscopy include fascia iliaca block, lumbar plexus block, intra-articular ropivacaine, and local anesthetic infiltration of levobupivacaine.[4] However, clinicians have yet to discover the nerve block technique with consistent evidence for improved pain control. One emerging regional anesthetic technique is the pericapsular nerve group (PENG) block. This involves an ultrasound-guided injection between

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the iliopsoas tendon and the pubic ramus, with the goal of blocking the sensory nerve branches that supply the anterior hip joint. Despite demonstrating fewer risks as an effective method of analgesia for hip fractures in 2018, the extent to which it improves clinical outcomes compared with other forms of analgesia is still unclear.[5] The purpose of this study was to perform a systematic review of clinical studies evaluating the PENG block in patients undergoing hip arthroscopy. We hypothesized that patients receiving the PENG block would have lower analgesic consumption, decreased time to discharge from the postanesthesia care unit (PACU), and lower pain scores compared to control groups.

Methods

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist. Two independent reviewers (G.T., J.D.) searched PubMed, Embase, and the Cochrane Library up to June 22, 2023. The electronic search strategy used was *hip arthroscopy pericapsular nerve block*. A total of 46 studies were reviewed by title and/or abstract to determine study eligibility based on inclusion criteria. Furthermore, reference lists for studies that met inclusion criteria were reviewed to see whether any further studies were identified that met inclusion criteria. In cases of disagreement, a third reviewer (M.J.K.) made the final decision. Inclusion criteria included comparative studies (Level of Evidence I-III) of patients undergoing the PENG block before hip arthroscopy. Studies were excluded if they were non-comparative studies, studies on patients who underwent the PENG block as rescue analgesia, or studies on patients who underwent another procedure in addition to hip arthroscopy during the same anesthesia, such as a periacetabular osteotomy. Data extraction from each study was performed by one author independently and then reviewed by a second author (M.J.K.). There was no need for funding or a third party to obtain any of the collected data, as the authors completed the data collection. Risk of bias for 2 randomized studies was assessed according to the Cochrane Collaboration's risk of bias tool,[6] which incorporates an assessment of randomization, blinding, completeness of outcomes data, selection of outcomes reported, and other sources of bias. Risk of bias for the 3 remaining nonrandomized studies was assessed according to the Risk Of Bias In Non-randomized Studies of Interventions-I risk of bias tool,[7] which incorporates an assessment of bias due to confounding, selection of participants, deviations from intended interventions, completeness of outcomes data, selection of outcomes reported, and other sources of bias. The Cohen kappa (κ) was calculated to determine the level of agreement between reviewers. A κ value of <0.20 indicates poor agreement; 0.21-0.40, fair agreement; 0.41-0.60, moderate agreement; 0.61-0.80, good agreement; and 0.81-1.00, very good agreement.[8]

Reporting Outcomes

Outcomes assessed included analgesic consumption, time to discharge, postoperative pain, and complications related to the nerve block. Analgesic consumption was measured in morphine milligram equivalents, time to discharge from the PACU was measured in minutes, and pain scores were measured using either the Numeric Rating Scale (NRS) or visual analog scale (VAS).

Study Methodology Assessment

The Modified Coleman Methodology Score (MCMS) was used to evaluate study methodology quality.[9] The MCMS has a scaled potential score ranging from 0 to 100. Scores ranging from 85 to 100 are excellent, 70 to 84 are good, 55 to 69 are fair, and less than 55 are poor. The primary outcomes assessed by the MCMS are study size and type, follow-up time, attrition rates, number of interventions per group, and proper description of study methodology.

Results

Five studies met inclusion and exclusion criteria (Fig 1). A total of 291 patients were included across the studies, including 141 patients who received the PENG block (group A) and 150 control patients (group B). The 5 studies included the following comparison groups: 0.9% normal saline injection, general anesthesia alone, and general anesthesia with intraoperative pericapsular bupivacaine injection. Patient age ranged from 25.5 to 36.0 years. The average body mass index ranged from 24.5 to 26.6 kg/m^2 and the overall percentage of males ranged from 37.7 to 66.1% (Table 1). In one of the randomized controlled trials, data collection was performed by research personnel blinded to the patient's study group.[10] The other Level I study blinded the patients, surgeons, and postoperative nurses, and the outcome parameters were recorded by a nurse who was not involved in the care of the patients (Table 2).[11]

Nerve Blockade

The PENG block was performed with the patient in the supine position. Using ultrasound guidance, a 22-gauge needle was inserted via a lateral-to-medial approach between the iliopsoas tendon and the pubic ramus, with the goal of blocking the branches of the femoral and obturator nerves. Patients received ropivacaine in 3 studies[10-12] (0.5%, 0.375%, unknown). In one study,[5] patients received either ropivacaine or bupivacaine. In another study,[10] patients underwent general anesthesia with a preoperative PENG block using ropivacaine (2 mg/mL) and an intraoperative

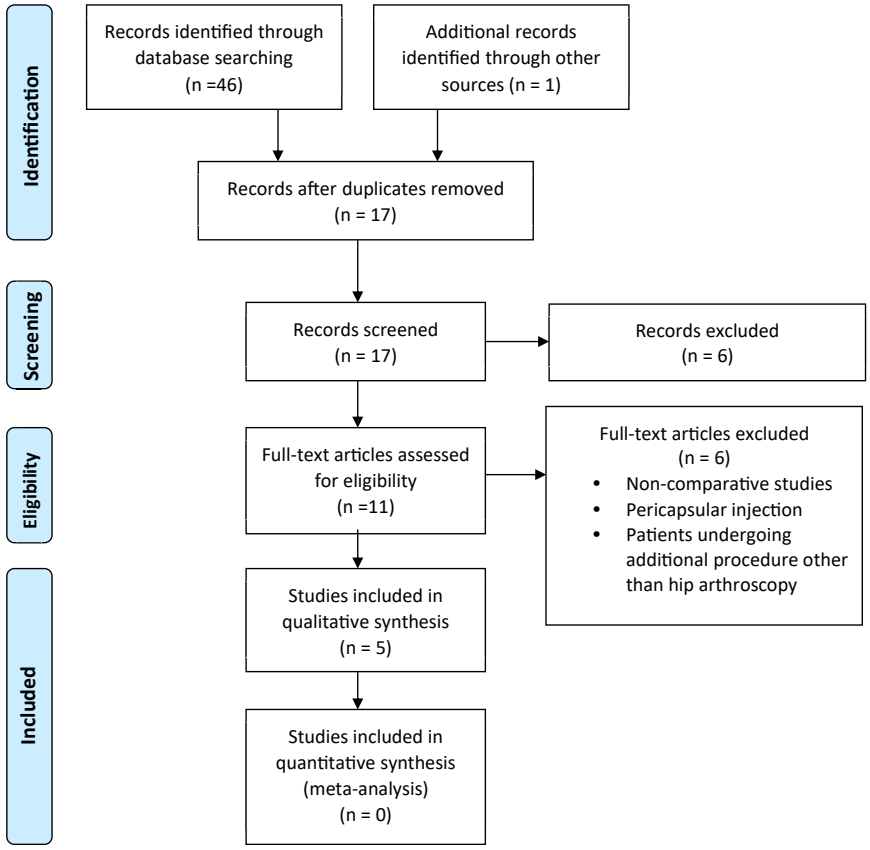

Fig 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.

pericapsular BKK (i.e., 50-mL bupivacaine, ketamine, ketorolac combination) injection. In another study,[13] the patients in the PENG group were also given an intraoperative pericapsular injection of 50 mL of bupivacaine, ketamine, and ketorolac.

Control Groups

All included studies used different control groups to examine the efficacy of the PENG block. In Amato et al.,[10] patients in group B received an ultrasound-guided injection with 5 mL of 0.9% normal saline directed within the subcutaneous tissue before receiving general anesthesia. In the study by Eppel et al.,[11] patients received a sham block of 20 mL of 0.9% normal saline via ultrasound guidance from a lateral-to-medial approach into the previously identified myofascial plane, with the ideal injection placement at the iliopsoas notch below the psoas tendon. In another study,[13] patients in the control group received either general anesthesia alone or general anesthesia with an intraoperative pericapsular injection of bupivacaine, though this technique was not specified. In 2 studies,[5,12] patients in group B received only general anesthesia.

Analgesic Consumption

Five studies[5,10-13] reported results for analgesic consumption (Table 3). Two studies[10,11] found no significant differences between groups. These were the 2 Level I studies included in this review. In one

Table 1. Studies Included

Study	LOE	N (A, B)	Patient Age (A, B), y	Sex, % Male	BMI, kg/m^2
Amato et al., 2022[10]	I	34, 34	29.4 ± 9.9, 32.5 ± 10.2	42.0	26.6
Eppel et al., 2023[11]	I	34, 34	30.9 ± 6.4, 30.1 ± 6.8	66.1	24.5
Kollmorgen et al., 2022[12]	III	25, 25	26.5 ± 10.4, 25.5 ± 8.8	46.0	26.2
Widmeyer et al., 2023[13]	III	20, 32	30.0, 30.8	NR	NR
Yusupov et al., 2023[5]	III	28, 25	36.0 ± 14.0, 31.0 ± 10.0	37.7	25.0

NOTE. n refers to the number of patients that underwent analgesia with either the pericapsular nerve group (PENG) block (group A) or control (group B). Gender is reported as a percentage. Age and body mass index (BMI) are reported as mean ± SD (range) (if reported).

LOE, Level of Evidence; NR, not reported; SD, standard deviation.

Table 2. Study Details

Study	Number of Patients		Blinded/Nonblinded	Primary Outcomes Measured		
	Case Group	Control Group				
Amato et al., 2022[10]	34	34	Blinded	Analgesic consumption	Pain (NRS)	–
Eppel et al., 2023[11]	34	34	Blinded	Analgesic consumption	Pain (VAS)	–
Kollmorgen et al., 2022[12]	25	25	Nonblinded	Analgesic consumption	Pain (VAS)	Time to discharge
Widmeyer et al., 2023[5]	20	20 (GA), 12 (GA/Marcaine)	Nonblinded	Analgesic consumption	Pain (VAS)	Time to discharge
Yusupov et al., 2023[13]	28	25	Nonblinded	Analgesic consumption	Pain (VAS)	Time to discharge

GA, general anesthesia; NRS, Numerical Rating Scale; VAS, visual analog scale.

study,[5] analgesic consumption in morphine milligram equivalents was significantly lower in the PENG block group both intraoperatively ($P < .001$) and in the PACU ($P < .001$) than the control group. Another study[12] found significantly lower intraoperative fentanyl use ($P < .04$) and narcotic use ($P < .001$) in the PENG group compared with the control group. Widmeyer et al.[13] found that the PENG group consumed significantly less opioids in the PACU ($P < .001$), significantly less opioids during total inpatient time ($P = .002$), and significantly less outpatient opioids over the first 2 weeks postoperatively ($P = .019$) than the general anesthesia or general anesthesia/bupivacaine groups.

Time to Discharge

Three studies[5,12,13] reported results for time to discharge from the PACU, all of which found significantly shorter time to discharge in the PENG block group compared with the control group (Table 4).

Pain

Four studies[5,11-13] reported on pain based on a VAS (Table 5). One study[12] found that initial VAS in the PENG group was significantly lower ($P = .04$) than in the control group. However, there were no significant differences between groups in terms of maximum VAS in the PACU or VAS at discharge ($P > .05$). Another study[11] found that postoperative pain scores were significantly lower in the PENG block group beginning at the 18th postoperative hour ($P = .032$), with the greatest difference at 24 hours ($P = .009$). Widmeyer et al.[13] showed that mean VAS pain scores in the PACU were significantly lower in the general anesthesia+PENG/BKK group compared with the general anesthesia group ($P < .001$) as well as the general anesthesia/bupivacaine group ($P = .48$). Yusupov et al.[5] found that the average highest pain score was significantly lower in the PENG block group than the control group ($P = .004$).

One study[10] reported on pain based on the NRS and found no significant differences between groups immediately following surgery ($P = .17$); at 24 hours after surgery at rest ($P = .98$), with activity ($P = .2$), or worst NRS score ($P = .2$); at 24-48 hours after surgery at rest ($P = .9$), with activity ($P = .6$), or worst NRS score ($P = .5$); or at 1 week following surgery at rest ($P = .7$) or with activity ($P = .4$).

Table 3. Analgesic Consumption

Study	PENG Block Group	Control Group	*P* Value
Yusupov et al., 2023[5]			
Intraoperative	16.9 ± 14.1	40.6 ± 18.3	<.001
PACU	14.4 ± 11.4	31.2 ± 20.1	<.001
Kollmorgen et al., 2022[12]			
Total pain medication required	34.3 ± 12.1	50.29 ± 11.2	.001
Widmeyer et al., 2023[13]			
PACU	4.1	26.3 (GA) 28.1 (GA/bupivacaine)	<.001
Total inpatient	17.6 ± 15.7	45.3 ± 34.6 (GA) 51.3 ± 40.8 (GA/bupivacaine)	.002 (GA) .003 (GA/bupivacaine)
Outpatient opioids 0-2 wk	18.9	23.9 (GA) 27.7 (GA/bupivacaine)	.019 (GA) .040 (GA/bupivacaine)

NOTE. All values are reported as morphine milligram equivalents (MMEs).
GA, general anesthesia; PACU, postanesthesia care unit; PENG, pericapsular nerve group.

Table 4. Time to Discharge From the PACU

Study	PENG Block Group, min	Control Group, min	*P* Value
Kollmorgen et al., 2022[12]	81.5 ± 19	95.8 ± 31	.01
Widmeyer et al., 2023[13]	47 ± 44	GA: 99 ± 40 GA/bupivacaine: 129 ± 59	<.001 <.001
Yusupov et al., 2023[5]	129 ± 34	161 ± 50	.008

GA, general anesthesia; PACU, postanesthesia care unit; PENG, pericapsular nerve group.

Additional Outcomes

One study[5] reported on antiemetic and benzodiazepine requirements and found that patients receiving the PENG block required significantly lower antiemetic administration ($P = .043$), with a trend toward significantly less benzodiazepine administration ($P = .059$). Another study[11] found that 3% of the study group experienced postoperative nausea and vomiting compared to 6% of control patients ($P = .542$).

Complications

Four studies[5,10-12] reported that no complications occurred from nerve block administration. One study[13] did not mention complications.

Modified Coleman Methodology Score

Table 6 shows the MCMS scores from the 5 included studies. Two studies[10,11] received a good score. Three studies[5,12,13] received a fair score.

Methodologic Quality Assessment

The results of the methodological quality assessment of the 3 nonrandomized studies using the Risk Of Bias In Non-randomized Studies of Interventions-I risk of bias tool are presented in Figure 2. All 3 studies[5,12,13] showed a low risk of bias due to confounding, as there were adequate prognostic variables that predicted baseline intervention and no patients who switched between interventions during the study period. No studies excluded eligible patients or used variable follow-up times based on intervention (low risk of bias), no studies deviated from the intended intervention (low risk of bias), and all studies clearly classified treatment type (low risk of bias). While all 3 studies[5,12,13] described using non-blinded methods for outcome assessment, none described differences in outcome measurement protocols between groups (moderate risk of bias). No studies showed bias due to missing data (low risk of bias). One study[12] demonstrated serious risk of bias in measurement of outcomes, as neither physicians nor patients were blinded to treatment type, whereas 2 studies[5,13] demonstrated moderate risk of bias, as it was unclear if both groups were blinded. Finally, no studies showed bias due to selective reporting (low risk of bias). The κ value was 0.83, reflecting very good agreement between reviewers.

The remaining 2 randomized studies[10,11] were assessed for methodologic quality using the Cochrane Collaboration's risk of bias tool. Sequence generation and allocation were adequately reported by both studies[10,11] (low risk of bias) and both studies were deemed to be at low risk for detection of bias because of the blinding of the outcome assessor and the patient. Neither study reported significant loss of follow-up (low risk of bias) and neither study was deemed to be at risk of bias for selective reporting or incomplete outcome data (low risk of bias).

Discussion

Based on the results of this systematic review, the 2 Level I studies on this topic[10,11] reported no significant difference between groups regarding opioid consumption following hip arthroscopy. However, the 3 nonrandomized studies showed patients undergoing hip arthroscopy with the PENG block may experience reduced opioid consumption, shorter time to discharge, and less pain in comparison with a variety of control groups. Of the 2 randomized controlled trials, one[10] reported pain based on the NRS and found no significant differences, whereas the other[11] found significantly lower postoperative pain scores in the PENG block group using the VAS. Amato et al.[10] did not find any statistically significant outcomes in their secondary outcomes either, including patient satisfaction with analgesia, opioid-related adverse events, or persistent

Table 5. Postoperative Pain Scores

Study	Method/Timing of Measurement	PENG Block Group	Control Group	*P* Value
Eppel et al., 2023[11]	24 hours postoperative	1.3 ± 0.9	2.4 ± 1.6	.009
Kollmorgen et al., 2022[12]	Initial score in PACU	3.7 ± 3.2	5.5 ± 2.9	.04
Widmeyer et al., 2023[13]	Mean score in PACU	3.9 (0-10)	GA: 7.7 (4-10) GA/bupivacaine: 6.6 (3-10)	GA: <.001 GA/Marcaine:.048
Yusupov et al., 2023[5]	Highest score in PACU	5.3 ± 2.1	7.0 ± 1.9	.004

NOTE. All scores are based on a visual analog scale (VAS). Scores are reported as mean ± SD (range) (if reported).
GA, general anesthesia; PACU, postanesthesia care unit; PENG, pericapsular nerve group; SD, standard deviation.

Table 6. Modified Coleman Methodology Score (MCMS)

Study	MCMS
Amato et al., 2022[10]	83
Eppel et al., 2023[11]	82
Kollmorgen et al., 2022[12]	63
Yusupov et al., 2023[5]	61
Widmeyer et al., 2023[13]	58

opioid use at 1 week. These results are difficult to interpret, given the varying levels of evidence of the studies. Although the Level III studies draw more favorable conclusions regarding the PENG block, the randomized controlled trials are less supportive of these results. Although the PENG block may serve as a viable option for pain management following hip arthroscopy, the current studies are inconsistent with methodological variability.

Nerve blocks are routinely used for other orthopaedic procedures. For anterior cruciate ligament reconstruction, the adductor canal block is a favorable alternative over femoral nerve block (FNB) for preservation of short-term muscle strength.[14] A 2015 triple-blinded randomized controlled trial looked at FNB for pain control in hip arthroscopy as well, and although they found significantly lower pain scores in the immediate postoperative period (6 hours or less), the FNB group had significantly more falls than the control group.[15] In a survey of American Shoulder and Elbow Surgeons members, >80% of surgeons use a regional nerve block on the operative day for total shoulder arthroplasty, labral and capsular stabilization procedures, and rotator cuff repair.[16] While nerve blocks are commonly used for certain knee[17] and shoulder[2] procedures, there is currently little consensus on pain control for hip patients who undergo arthroscopy.[15]

The most effective method for pain control following hip arthroscopy is a controversial topic among orthopaedic surgeons. Opioid prescriptions are often part of the postoperative plan, and orthopaedic surgeons are the third-highest prescribers of narcotic medications.[18] Given the pervasive opiate crisis, alternative methods of appropriate pain management are more desirable. A systematic review of randomized controlled trials published in 2021 evaluated the use of the fascia iliaca block for postoperative pain control after hip arthroscopy.[4] Despite the previous popularity of this nerve block, the results showed that none of the outcomes, including pain scores and total analgesic consumption, demonstrated superiority in the fascia iliaca group compared with other forms of analgesics, including intraoperative intra-articular or extracapsular anesthetic injections, and nonsteroidal anti-inflammatory drugs. Thus, the optimal nerve block for hip arthroscopy patients has yet to be determined.

Previous research has described several methods of pain management for hip arthroscopy. A recent systematic review included femoral nerve block, lumbar plexus block, fascia iliaca block, intra-articular injections, soft-tissue injections, and celecoxib, and found varying levels of efficacy.[19] For example, although femoral nerve and lumbar plexus blocks offered improved pain relief, these also were associated with increased fall rates. Another study reviewing femoral,

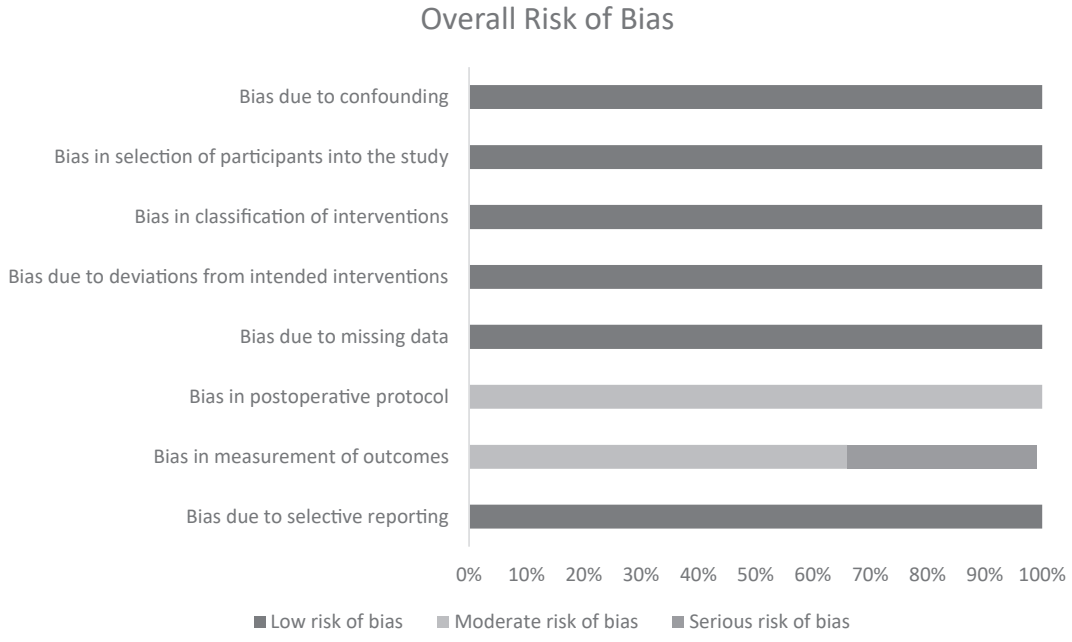

Fig 2. Risk of bias graph. Risk of bias is presented as a percentage across all included studies.

fascia iliaca, lumbar plexus, and L1 and L2 paravertebral nerve blocks found significantly lower postoperative pain scores, decreased opioid consumption, and greater levels of patient satisfaction, with no serious acute complications and a low incidence of long-term complications.[20] In addition, postoperative pain may be associated with surgeon experience, traction and procedure time, and time to mobilization.[11] Overall, there is evidence to suggest that adjunct analgesia does reduce postoperative opioid use, prompting further investigation.[21]

The use of the PENG block was published in 2018 with a series of 5 patients undergoing surgery for hip fractures.[22,23] All patients had improved pain and preserved motor function without quadriceps weakness. Subsequent studies continued to evaluate its use in hip arthroplasty and hip fractures, and its advantage in providing anesthesia to the branches of the femoral and obturator nerves without the motor issues of the femoral nerve and lumbar plexus blocks. A cadaveric study of innervation of the anterior hip capsule found consistent innervation by the femoral and obturator nerves, with contribution from the accessory obturator nerve in 7 of 13 specimens.[24] Given potential anatomic variability, the blockade may produce better results in those with more typical anatomy. The first randomized, double-blinded comparative trial of the PENG block versus the femoral nerve block following hip fracture surgery showed favorable outcomes in the PENG group.[25] The success of the PENG block in hip fractures begs the question of whether it may be an optimal method of pain management following hip arthroscopy as well. One consideration may be the nature of open procedures compared with arthroscopy: in arthroscopy, fluid is used to facilitate visualization of the joint, potentially causing pain due to distension of the capsule. In addition, irrigation following preoperative PENG block may decrease its efficacy, without a clear method for confirming sufficient blockade.

Limitations

The limitations of this study should be noted. First, only 5 studies met inclusion criteria. Three of these studies were retrospective and nonrandomized. There was heterogeneity regarding interventions performed in the control group, the duration over which opioid consumption was measured, and the methods of comparing pain scores between the 2 groups. Only 3 studies reported time to discharge.[5,12,13] For pain, one study[10] used the NRS, whereas the others used the VAS. Finally, no studies compared the PENG block with another type of nerve block.

Conclusions

Systematic review of randomized controlled trials shows that patients undergoing hip arthroscopy who receive a PENG block do not consume fewer opioids for postoperative pain control than patients who do not receive the block.

Disclosure

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: A.J.S. reports consulting fees from Mitek, outside the submitted work; leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid: American Academy of Orthopaedic Surgeons, American Orthopaedic Society for Sports Medicine, and New Jersey Orthopaedic Society, outside the submitted work; and stock or stock options from Biomet, Pfizer, CONMED Linvatec, Smith & Nephew, Johnson & Johnson, and Stryker, outside the submitted work. W.M.R.H. reports consulting fees from Smith & Nephew, outside the submitted work; payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing or educational events from Vericel, outside the submitted work; and leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid: Arthroscopy Association of North America. M.J.K. reports leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid: *Arthroscopy*. All other authors (G.T., J.D.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

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