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Guidelines

PROSPECT guideline for total hip arthroplasty: updated systematic review and procedure-specific postoperative pain management recommendations

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Summary

Introduction The Procedure Specific Postoperative Pain Management (PROSPECT) collaboration develops evidence-based recommendations integrating analgesic efficacy, safety and functional recovery. Since publication of the 2021 PROSPECT guidelines for total hip arthroplasty, new evidence, particularly on motor-sparing regional techniques, has emerged. This systematic review updates the 2021 recommendations for postoperative pain management after elective primary total hip arthroplasty.

Methods Databases were searched systematically for randomised controlled trials and systematic reviews published between January 2020 and June 2024 evaluating peri-operative analgesic or surgical interventions for total hip arthroplasty. Studies involving non-randomised designs or lacking validated pain outcomes were not included. Evidence was synthesised according to PROSPECT methodology, focusing on pain within 24 h; opioid consumption; functional recovery; and adverse effects. Recommendations were graded by expert consensus.

Results A total of 103 studies were included. Core recommendations remain unchanged: scheduled paracetamol and non-steroidal anti-inflammatory drugs, combined with a single intravenous dose of dexamethasone (≤ 10 mg). Low-dose intrathecal morphine (0.1 mg) may be considered with spinal anaesthesia in hospitalised patients. Among regional techniques, supra-inguinal fascia iliaca compartment block and pre-operative pericapsular nerve group block provided the most consistent analgesia. Quadratus lumborum and lumbar erector spinae plane blocks showed inconsistent efficacy and increased risk of motor weakness and are not recommended. Single-shot local infiltration analgesia remains an alternative when regional techniques are unavailable.

Discussion In addition to previous recommendations, supra-inguinal fascia iliaca compartment block and pre-operative pericapsular nerve group block are recommended as preferred regional techniques for total hip arthroplasty, with single-shot local infiltration analgesia as an alternative when regional anaesthesia is not feasible.

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Recommendations

1. Paracetamol and non-steroidal anti-inflammatory drugs or cyclo-oxygenase (COX)-2 inhibitors should be administered routinely unless contraindicated.
2. A single intravenous dose of dexamethasone (≤ 10 mg) is recommended for its analgesic, anti-inflammatory, and antiemetic effects.
3. Low-dose intrathecal morphine (≤ 0.1 mg) may be considered in patients undergoing total hip arthroplasty (THA) under spinal anaesthesia in inpatient settings.
4. Supra-inguinal fascia iliaca compartment block is recommended as an effective component of multimodal analgesia. Pre-operative pericapsular nerve group (PENG) block is recommended as an alternative motor-sparing technique with comparable efficacy.
5. Single-shot local infiltration analgesia (LIA) may be considered as an alternative when regional anaesthesia is not feasible or contraindicated.

Why was this guideline developed?

This guideline was developed to update the 2021 PROSPECT recommendations for postoperative pain management after THA in light of substantial new evidence (2020–2024), particularly on motor-sparing regional techniques and enhanced-recovery pathways.

What other guidelines are available on this topic?

Previous PROSPECT THA recommendations (2021), enhanced recovery after surgery (ERAS) pathways and consensus statements such as those from the International Consensus on Anaesthesia-Related Outcomes after Surgery (ICAROS) group provide general or procedure-related recommendations for analgesia after hip arthroplasty.

How does this guideline differ from other guidelines?

Unlike broader peri-operative guidelines, this PROSPECT update uses procedure-specific methodology integrating analgesic efficacy, safety and functional recovery.

Introduction

Total hip arthroplasty (THA) is an effective procedure that provides substantial pain relief and restores mobility in patients with advanced hip pathology [1]. However, postoperative pain control after THA remains a major challenge. Inadequate analgesia not only hinders early mobilisation and rehabilitation but reduces patient satisfaction, increases opioid reliance and may contribute to complications such as thromboembolism and delayed discharge [2].

The Procedure Specific Postoperative Pain Management (PROSPECT) Working Group is a collaboration of anaesthetists and surgeons that formulates procedure-specific recommendations for pain management after common surgical procedures. The PROSPECT methodology considers not only the efficacy of an analgesic intervention but also its feasibility, safety and associated functional outcomes [3]. The previous PROSPECT recommendations for elective primary THA published in 2021 synthesised evidence from 2010 to December 2019 [4]. Since then, new evidence has emerged, particularly regarding regional analgesia techniques. The shift toward shorter hospital stays and outpatient THA emphasises the importance of refining motor-sparing, high-efficacy analgesic techniques that promote early rehabilitation and safety.

Given this evolving evidence base, an updated systematic review was performed with the aim of updating the recommendations for pain management after elective primary THA. The primary outcomes included postoperative pain scores and analgesic requirements within the first 24 h after surgery.

Methods

This systematic review was conducted according to the PROSPECT methodology, which provides a structured framework for developing evidence-based, procedure-specific analgesic recommendations [3]. The review was designed and reported following the PRISMA 2020 statement. The primary aim was to update the previous PROSPECT systematic review on elective primary THA published in 2021 [4], by identifying and qualitatively synthesising new evidence published from 1 January 2020

to 1 June 2024. The detailed database-specific search strategy is presented in online Supporting Information Appendix S1.

Studies were eligible if they met the following criteria: adult patients undergoing elective primary THA; designed as a randomised controlled trial or systematic review/meta-analysis of randomised controlled trials; and investigation of any peri-operative analgesic, anaesthetic or surgical intervention aimed at improving postoperative pain management. Studies had to report pain outcomes using a linear scale such as the visual analogue scale or numerical rating scale and could include secondary endpoints such as opioid consumption; functional recovery; or adverse events. Only articles published in English and registered in a recognised clinical trial database were considered. Exclusion criteria included studies of revision arthroplasty or fracture surgery; non-randomised designs; conference abstracts; retracted publications; or papers lacking full-text availability.

Two independent reviewers (MC and DB) screened titles and abstracts for relevance, followed by full-text assessment of potentially eligible articles. Disagreements were resolved by discussion and consensus. A third author (MVDV) oversaw the process of resolving any remaining conflicts. Data extraction was performed using a predefined template, capturing study design; patient characteristics; type and timing of intervention; comparator; primary and secondary outcomes; and reported complications. Overlaps among systematic reviews and meta-analyses were carefully examined.

In accordance with the updated PROSPECT methodology [3], randomised controlled trials representing basic analgesics (i.e. paracetamol, non-steroidal anti-inflammatory drugs, COX-2 specific inhibitors and opioids) were not included in this new review. These components are considered essential to all multimodal analgesic regimens. Accordingly, this update focused on evaluating evidence regarding regional anaesthesia techniques; LIA; neuraxial adjuvants; and systemic `non-basic analgesic´ pharmacological interventions. Each intervention was compared with the recommendations of the 2020 PROSPECT guideline to determine whether the newly available evidence warranted modification of prior conclusions [4].

Due to methodological heterogeneity, meta-analysis was not undertaken. Evidence was synthesised based on the number and methodological quality of studies, their reproducibility, consistency of outcomes and clinical applicability. Emphasis was placed on interventions which could reduce pain intensity within the first 24 h after surgery (the period of maximal postoperative pain); their influence on opioid consumption and functional recovery; and incidence of adverse effects [5]. Each intervention was classified as recommended, not recommended, or having insufficient evidence based on consistency, safety and clinical feasibility. Final recommendations were reached by consensus among the review group and changes relative to the 2021 PROSPECT guideline were explicitly noted.

Results

The database search identified 11,734 records. After removing 3189 duplicates, 8545 titles and abstracts were screened for eligibility. Following initial screening, 144 full-text articles were retrieved and assessed. A total of 103 studies met the inclusion criteria and were included in the final qualitative synthesis, comprising 71 randomised controlled trials and 32 systematic reviews or meta-analyses published between January 2020 and June 2024. The study selection process is summarised in Figure 1.

Included randomised controlled trials comprised 6916 patients undergoing elective primary THA performed under either spinal or general anaesthesia. Study sizes ranged from 24 to 476 patients. Trials evaluated systemic pharmacologic strategies; neuraxial interventions; regional blocks; local infiltration techniques; and multimodal combinations. Most studies were conducted within enhanced recovery after surgery (ERAS) pathways, reflecting the trend toward early mobilisation and reduced hospital stay.

Table 1 summarises the key findings from trials evaluating recommended interventions, and Table 2 summarises the key results from trials assessing non-recommended interventions. Online Supporting Information Table S1 lists excluded trials and reasons for exclusion. The risk of bias assessment of included trials is available in online Supporting Information Figure S1.

Regional anaesthesia techniques

Fascia iliaca compartment block

Fascia iliaca compartment block (FICB) was evaluated in six studies, four using the supra-inguinal approach [6–9] and one using the infra-inguinal approach [10]. The 2021 guidance recommended FICB without distinction between infra- and supra-inguinal approach because of the restricted number of randomised controlled trials at that time. However, evidence for FICB has evolved considerably. Integration of both pre-2020 and contemporary data reveals that the infra-inguinal approach provides inconsistent and often suboptimal analgesia, when compared with more proximal or anatomically targeted technique of the supra-inguinal FICB approach. Between 2020 and 2024, one randomised controlled trial examined

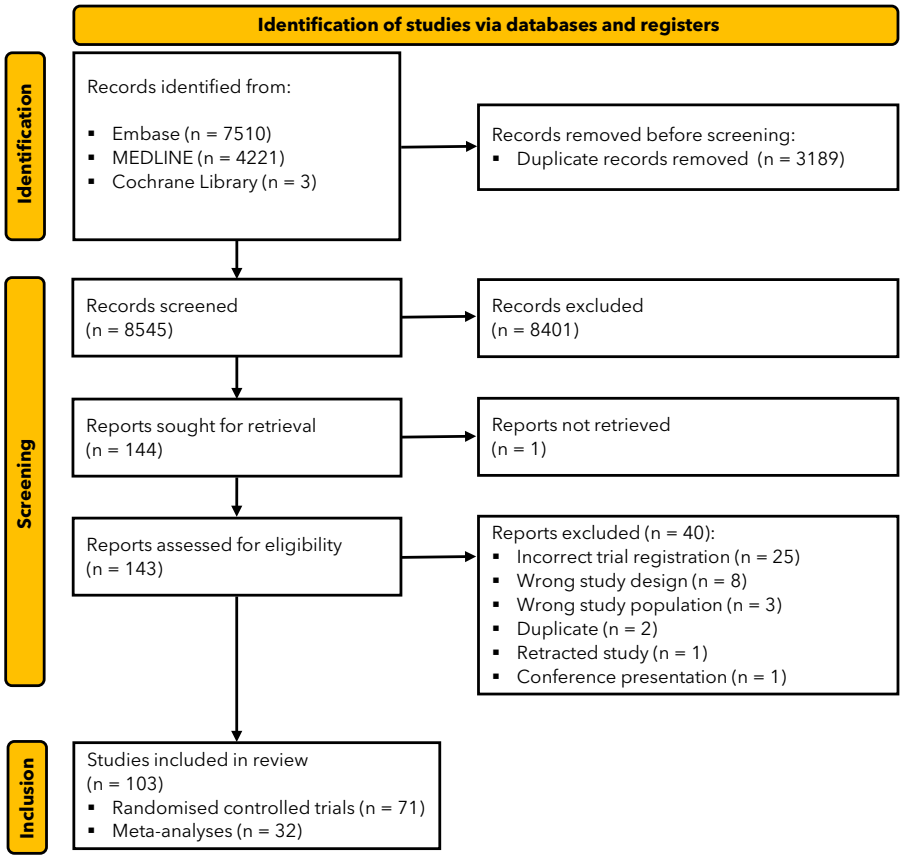

Figure 1 Study flow diagram.

postoperative infra-inguinal FICB [10] showing no clinically relevant reductions in postoperative pain or opioid requirements. Overall, the modest analgesic effect, inconsistent nerve coverage and potential interference with early mobilisation limits the contemporary role of infra-inguinal FICB in analgesia for THA.

By contrast, high-quality randomised controlled trials evaluating pre-operative supra-inguinal FICB have shown consistent and clinically relevant benefits in patients undergoing THA with a posterolateral approach [6–8]. Across these studies, supra-inguinal FICB was associated with significant reductions in opioid consumption within the first 24–48 h (approximately 30–50%), as well as lower pain scores both at rest and during movement. In addition, improvements in functional recovery were observed, including better orthostatic tolerance and a lower incidence of opioid-related adverse effects, without evidence of clinically relevant motor impairment. Nevertheless, a recent trial conducted in lateral-approach THA within an intensive multimodal analgesic regimen, found no additional benefit of supra-inguinal FICB, suggesting that the incremental effect of the block may be reduced when robust systemic analgesia is already employed [9]. Taken together, recent findings strengthen and extend previous evidence supporting the efficacy of longitudinal supra-inguinal FICB, confirming this block as a reliable option for postoperative analgesia after THA [11]. In the studies reviewed, a volume of approximately 40 ml was typically used to achieve adequate supra-inguinal spread with the longitudinal technique [11, 12].

Pericapsular nerve group block

The pericapsular nerve group (PENG) block was evaluated in 12 studies [13–24]. Pascarella et al. first established its superior early analgesia and opioid-sparing effects compared with placebo in THA [13], findings subsequently corroborated by two other trials, reporting reduced dynamic pain without motor impairment [14, 15]. A trial validated these outcomes in a multicentre randomised controlled trial, confirming its favourable motor-sparing profile and suitability for enhanced recovery programs [16].

Comparative evidence suggests that pre-operative PENG and supra-inguinal FICB offer comparable clinical benefit. In a non-inferiority trial, no significant difference has

Table 1 Overall PROSPECT recommendations for pain management in patients undergoing primary total hip arthroplasty.

	Level of evidence	Strength of recommendation
Pre-operative and intra-operative		
Paracetamol combined with non-steroidal anti-inflammatory drugs or cyclo-oxygenase-2-selective inhibitors administered pre-operatively or intra-operatively, unless contraindicated	N/A	N/A
Dexamethasone up to 10 mg, intravenously	High	Strong
Local/regional analgesia techniques		
Single shot suprainguinal fascia iliaca block OR single shot pericapsular nerve group (PENG) block	High	Strong
Local infiltration analgesia if regional blocks are not possible or contraindicated	High	Strong
Intrathecal morphine 0.1 mg may be considered, If the patient has received spinal anaesthesia for the surgery and the procedure is performed in and inpatient setting	High	Strong
Postoperative		
Paracetamol combined with non-steroidal anti-inflammatory drugs or cyclo-oxygenase-2-selective inhibitors administered as scheduled, unless contraindicated	N/A	N/A
Opioid for rescue	N/A	N/A

been found between PENG and supra-inguinal FICB in terms of pain control, opioid consumption or early mobilisation, functional recovery and patient-reported outcomes, indicating equivalent postoperative efficacy [17]. Similarly, a study comparing PENG with the quadratus lumborum block (QLB), found no clinically significant differences in analgesic outcomes, suggesting equivalent efficacy across these anterior and posterior motorsparing approaches [18]. More recently, a trial compared PENG with LIA and likewise found no significant difference in pain relief, opioid use or functional recovery, indicating that both techniques may achieve similar levels of postoperative analgesia [19].

Importantly, evidence indicates that the timing of PENG administration markedly influences its efficacy. Postoperative or intra-operative PENG appears less effective, while pre-operative performance provides optimal analgesia and opioid-sparing benefits. Several trials underscore this point: one found that postoperative PENG offered no advantage over local infiltration analgesia [20]; and another reported comparable results between PENG and LIA [21]. Conversely, a trial showing that pre-operative PENG produced analgesia comparable to supra-inguinal FICB with less motor impairment, supporting its preferential use before surgical incision rather than after wound closure [22]. The combination of PENG and LIA has not shown additional benefit and is not recommended. Two studies determined that when LIA is performed, the addition of a PENG block neither improves analgesia nor reduces opioid consumption, indicating redundancy and limited procedure-specific value for the combined approach [23, 24]. Interestingly, this conclusion is contrasted by a recent component network meta-analysis, which ranked PENG with LIA among the most favourable options in primary THA [25].

Lumbar erector spinae plane block

Lumbar erector spinae plane (lumbar ESP) block has been evaluated in six studies [26–31]. Evidence regarding the use of lumbar ESP block for THA has expanded in recent years, positioning it as a potential motor-sparing alternative to the supra-inguinal FICB. The lumbar ESP block, typically performed at the L3 level, aims to achieve indirect spread toward the dorsal rami and ventral branches of the lumbar plexus through inter-fascial diffusion. When used as a single-shot injection, it has been shown to provide variable but occasionally broad somatic and visceral analgesia of the hip region [32]. However, available clinical data reveal heterogeneous outcomes. One randomised controlled trial found no statistically or clinically significant differences in postoperative pain at rest or during movement when pre-operative lumbar ESP block at the L3 level was compared with standard multimodal analgesia without regional techniques [26]. However, a transient benefit limited to the early postoperative period was also observed, with significantly lower opioid consumption within the first 8 h after surgery after THA with spinal anaesthesia, a difference which disappeared by 24 h. Another study showed no analgesic improvement with lumbar ESP block. However, in that study, the block was performed at the L1 level, which, although theoretically favourable for spread towards the lumbar plexus, did not translate into clinically relevant analgesic benefit [27].

Table 2 Analgesic interventions that are not recommended for pain management in patients undergoing primary total hip arthroplasty.

Intervention	Reasons for not recommending
Regional analgesia techniques	
Infra-inguinal fascia iliaca block	Lack of procedure-specific evidence
Postoperative pericapsular nerve group block	Lack of procedure-specific evidence
Lumbar erector spinae plane block	Inconsistent procedure-specific evidence
Ilio-psoas block	Lack of procedure-specific evidence
Circum-psoas block	Limited procedure-specific evidence
Quadratus lumborum block – anterior (transmuscular)	Procedure-specific evidence, but adverse effects
Quadratus lumborum block – posterior or lateral	Lack of procedure-specific evidence
Quadratus lumborum block – continuous	Lack of procedure-specific evidence
Obturator nerve block	Lack of procedure-specific evidence
Lateral femoral cutaneous nerve block	Lack of procedure-specific evidence
Postoperative lateral femoral cutaneous nerve block	Lack of procedure-specific evidence
Paravertebral block	Lack of procedure-specific evidence
Lumbar plexus block	Procedure-specific evidence, but adverse effects
Local infiltration analgesia adjuncts	Inconsistent procedure-specific evidence
Local infiltration analgesia in combination with other blocks	Inconsistent procedure-specific evidence
Continuous local infiltration analgesia	Lack of procedure-specific evidence and potential adverse effects
Intrathecal drugs	
Dexmedetomidine	Limited procedure-specific evidence
Oxytocin	Lack of procedure-specific evidence
Systemic drugs	
Methylprednisolone	Limited procedure-specific evidence
Postoperative dexamethasone	Inconsistent procedure-specific evidence
Duloxetine	Limited procedure-specific evidence
Intravenous dexmedetomidine	Lack of procedure-specific evidence
Melatonin	Lack of procedure-specific evidence
Gabapentinoids	Inconsistent evidence and side effects
Surgical techniques	
Super-PATH APPROACH	Lack of procedure-specific evidence
Direct anterior approach	Lack of procedure-specific evidence
3-D immersive reality	Lack of procedure-specific evidence

When directly compared with supra-inguinal FICB, postoperative lumbar ESP block showed comparable analgesic efficacy but superior functional recovery. Two trials reported similar pain scores and opioid use between the two techniques, while lumbar ESP was associated with earlier ambulation and better preservation of quadriceps strength, supporting its role as a feasible motor-sparing option for enhanced recovery pathways [28, 29]. Conversely, when compared with the infra-inguinal FICB, postoperative lumbar ESP provided superior analgesia during the first 8 h postoperatively; however, this study lacked a comprehensive multimodal analgesic baseline (no non-steroidal anti-inflammatory drugs or COX-2 specific inhibitor), limiting generalisability and reinforcing the limited value of infra-inguinal FICB in contemporary protocols [30]. Furthermore, in settings where LIA is administered intra-operatively, one trial showed that addition of a pre-operative lumbar ESP block conferred no incremental benefit in pain relief or opioid consumption [31].

Quadratus lumborum block

The quadratus lumborum block (QLB) has been evaluated in 12 studies [18, 33–43]. Different approaches have been proposed to QLB for THA, namely lateral (type 1) in two studies; posterior (type 2) in one study; and anterior (trans-

muscular, type 3) in eight studies. The available evidence shows limited analgesic efficacy of both the lateral and posterior QLB for THA. A placebo-controlled randomised controlled trial found that the posterior QLB did not reduce postoperative opioid consumption or pain scores compared with placebo, showing no meaningful effect on the pain trajectory during the first 24 h [33]. Similarly, a study compared the QLB with the supra-inguinal FICB observed no clinically significant differences in opioid use, pain intensity or functional recovery [34]. When the lateral QLB was compared with the lumbar plexus block in a non-inferiority design based on postoperative opioid consumption, the non-inferiority hypothesis was rejected, confirming the inferior analgesic performance of QLB relative to direct plexus blockade [35].

The anterior, or transmuscular, QLB allows the spread of local anaesthetic toward the lumbar plexus within the interfascial plane between the quadratus lumborum and psoas major muscles [44]. This approach provides more direct access to the lumbar nerve roots and their articular branches and, therefore, has been associated with more extensive sensory coverage of the hip region. Recent evidence confirms that anterior QLB can be effective after THA when compared with placebo or suboptimal control groups. Studies have shown significant reduction in pain and opioid consumption when compared to placebo and have reported superior analgesia compared with LIA in a study which did not include comprehensive systemic multimodal analgesia [36, 37]. Similarly, when administered postoperatively, the anterior QLB provided analgesic benefit which was limited to the first 8 h after surgery. This trial also failed to include a baseline multimodal analgesic regimen [38]. However, when compared with other established techniques, its advantages disappear. The anterior QLB has shown comparable efficacy to femoral nerve block, supra-inguinal FICB block, infra-inguinal FICB block, PENG block and lumbar plexus block, with no clinically meaningful differences in static or dynamic pain scores, opioid consumption or early mobilisation outcomes [18, 39–42]. Moreover, another trial reported that when performed postoperatively, the anterior continuous QLB was inferior to continuous femoral nerve block in terms of analgesic efficacy and opioid-sparing effect, further questioning its utility as a stand-alone postoperative technique [43]. Concerns remain regarding its risk–benefit profile. The potential for serious complications, such as retroperitoneal hematoma and bleeding, together with higher incidence of motor weakness in the operated limb, continues to limit its acceptance into routine clinical practice [45].

Local infiltration analgesia (LIA)

Local infiltration analgesia was evaluated in 12 studies [19, 20, 46–55]. With recent evidence showing heterogeneous results depending on the study design and the use of comprehensive multimodal analgesia, the role of LIA in THA remains debated. Two studies observed lower rest and movement pain scores within the first 6 h postoperatively compared with no infiltration but this effect was not clinically relevant, disappeared by 12 h, and did not produce any opioid-sparing benefit [46, 47]. When compared with other loco-regional or infiltration techniques, the results remain equivocal. In one randomised controlled trial, slightly lower movement pain scores were reported at 3 h and 6 h postoperatively compared with the PENG block, although these differences were not clinically relevant [19]. Another study found comparable pain control, opioid use and quadriceps strength between LIA and PENG, supporting non-inferiority rather than superiority [20]. Conversely, one investigation showed worse analgesia with LIA compared with either PENG or QLB, reflected by higher static and dynamic pain scores [48].

Comparisons with neuraxial or other regional techniques yielded similarly inconsistent findings. One study reported equivalent outcomes among LIA, epidural analgesia and their combination [49]. A separate trial observed better early (0–12 h) but worse late (12–48 h) analgesia with LIA compared with combined lumbosacral plexus block [50]. Additional evidence confirmed that postoperative peripheral nerve blocks, targeting the femoral, obturator and quadratus femoris nerves, provided superior and longer-lasting analgesia than LIA alone [51].

The influence of timing and adjuvant composition has also been investigated. In one study, early peri-articular injection performed before arthrotomy provided better immediate postoperative pain relief than late infiltration [52]. Another trial reported improved analgesia when corticosteroids were added to the infiltration mixture [53]. More recently, a randomised controlled trial comparing various adjuvant combinations found prolonged analgesia lasting up to 12 h when ropivacaine was combined with dexamethasone, epinephrine, magnesium sulphate and bicarbonate, although the overall clinical impact remained limited [54]. Collectively, these data suggest that both composition and timing may influence the duration of analgesia, but not the overall magnitude of benefit.

Overall, the available evidence indicates that LIA provides transient analgesic benefit confined to the early postoperative period, particularly when regional blocks or optimal multimodal analgesia are not used. Its efficacy does

not exceed that of motor-sparing regional blocks, such as the supra-inguinal FICB or PENG, nor does it consistently improve opioid use, pain beyond 24 h or functional recovery.

Continuous LIA, involving postoperative infusion of local anaesthetic via intra-articular or fascial catheters, has also shown no clinical advantage over single-shot LIA or standard multimodal analgesic protocols, while introducing a higher risk of adverse events. In one randomised controlled trial, no statistically or clinically significant differences in pain scores or opioid consumption were observed among continuous LIA, continuous fascial infusion and saline control, although a 5% incidence of deep infection was reported [55].

Other regional analgesic techniques

Iliopsoas block targets the space between the iliopsoas muscle and the anterior capsule of the hip. Evidence in THA is limited and inconsistent. A prospective randomised controlled trial showed no clinically meaningful reduction in postoperative pain or opioid consumption compared with standard multimodal analgesia [56]. Given the lack of reproducible analgesic benefit, the iliopsoas block cannot be recommended for routine use in THA. Anatomical imaging studies further suggest that injectate often remains confined to the iliopsoas compartment, with inconsistent spread to the articular branches of the anterior hip capsule.

Selective blockade of the obturator nerve and the lateral femoral cutaneous nerve have not proven to be clinically contributory for postoperative analgesia after THA. When performed pre-operatively, obturator nerve block does not improve pain control or reduce opioid consumption in the presence of a multimodal analgesic regimen which includes surgical periarticular infiltration [57]. Similarly, pre-operative lateral femoral cutaneous nerve block, even when combined with femoral nerve block, failed to establish superiority over placebo in a randomised controlled trial which lacked a comprehensive baseline multimodal analgesic regimen [58]. Furthermore, another study confirmed the limited and potentially inferior analgesic role of postoperative lateral femoral cutaneous nerve block when compared with LIA, despite a comprehensive multimodal protocol that included a PENG block [59].

The lumbar plexus block remains an effective regional analgesic technique for THA, but its risk–benefit profile is less favourable when compared with safer and equally effective alternatives. Evidence from two studies supports this conclusion. One trial showed that continuous lumbar plexus block provided postoperative analgesia comparable to epidural analgesia, confirming its efficacy as a viable alternative for major hip surgery [60]. However, another found that single-shot lumbar plexus block, although equally effective as the supra-inguinal FICB for postoperative pain control, resulted in greater sensory blockade and delayed functional recovery, reflecting a higher potential for motor impairment [8].

A novel, posterior interfascial technique targeting circumferential spread around the psoas muscle related to the lumbar plexus, the circum-psoas block, aims to achieve broader perineural spread around the psoas muscle. This potentially encompasses the femoral, obturator and lateral femoral cutaneous nerves. A randomised controlled trial established that circum-psoas block provided superior early analgesia, reduced opioid consumption, longer time to first rescue analgesic and lower incidence of quadriceps weakness compared with supra-inguinal FICB, alongside higher dermatomal coverage of the anterior thigh and hip [61]. Despite these encouraging results, the technique remains relatively novel, with limited procedure-specific validation in THA. Therefore, circum-psoas block cannot yet be recommended for routine use, pending confirmation of safety, reproducibility and efficacy in larger trials.

Intrathecal analgesics

Intrathecal morphine was evaluated in two additional studies [62, 63]. In one randomised controlled trial, intrathecal morphine at doses of 0.1 mg and 0.2 mg significantly reduced pain scores over 24 h and decreased opioid consumption compared with plain local anaesthetic; the lowest pain scores were observed with 0.2 mg, although this dose was associated with a higher incidence of pruritus and mild postoperative nausea [62]. Another study confirmed the analgesic benefits of low-dose intrathecal morphine (0.1 mg), which improved early pain control without increasing respiratory depression or affecting sleep apnoea indices [63]. Collectively, these findings reinforce the role of low-dose intrathecal morphine (0.1 mg) as an effective and safe adjunct in in-hospital settings, while higher doses should be used with caution due to dose-dependent adverse effects.

Evidence for other intrathecal agents remains limited and inconclusive. In one study, intrathecal dexmedetomidine (5 μg) prolonged both sensory and motor block compared with intravenous administration but failed to show any clear clinical advantage in postoperative pain control or opioid reduction, whilst increasing the risk of prolonged motor impairment [64]. Another randomised controlled trial found no difference in pain trajectory or opioid consumption between intrathecal oxytocin and

saline control, although a modest improvement in late functional recovery was noted, underscoring the lack of procedure-specific analgesic benefit for these drugs [65].

Systemic interventions

Corticosteroids

Recent randomised controlled trials have reinforced the analgesic, anti-inflammatory and antiemetic properties of dexamethasone, while clarifying optimal dosing and timing regimens. In one study, intravenous peri-operative dexamethasone administered as 10 mg pre-operatively and 10 mg postoperatively, significantly reduced pain at rest and during ambulation within 24 h, decreased tramadol consumption and reduced duration of hospital stay without increasing complications [66]. Another trial confirmed superior pain control, lower opioid requirements and reduced postoperative nausea and fatigue when dexamethasone was given peri-operatively [67]. Further evidence indicated that multidose regimens, with both pre- and postoperatively administration (total 20–30 mg intravenously), provided good analgesia, reduced morphine consumption and improved early mobility and patient satisfaction, compared with a single dose [68, 69].

Comparative dosing studies have refined the optimal use of dexamethasone [70]. One trial found no additional benefit from a higher (1 $mg.kg^{-1}$) compared with a lower (0.3 $mg.kg^{-1}$) dose, suggesting that excessive dosing does not enhance analgesia or functional recovery [71]. Inconsistent findings have been reported for higher or repeated doses, partly due to study heterogeneity and potential adverse effects which remain incompletely addressed. Evidence for methylprednisolone remains limited and inconsistent. Some studies have reported lower early pain scores, improved sleep quality and reduced opioid consumption following pre-operative intravenous methylprednisolone (125 mg). However, these trials lacked baseline multimodal analgesia and were underpowered to detect clinically relevant differences in opioid consumption, functional recovery and adverse events [72]. Moreover, no clear advantage over dexamethasone has been shown to date.

Other systemic interventions

Analgesic effects of other pharmacologic interventions have been examined, including duloxetine [73, 74]; carbazochrome sodium sulfonate [75]; pregabalin and melatonin [76]; and dexmedetomidine [77]. Duloxetine (60 mg daily from two days before until 14 days after surgery) reported significantly lower pain scores during movement and reduced morphine consumption compared with placebo, within the first three postoperative weeks [73]. However, these differences were below the threshold for clinical relevance and were not sustained at three months. Similarly, another trial observed reduced pain scores during walking and hip flexion from postoperative day 3 to week 3, along with lower opioid use, in patients treated with duloxetine 60 mg daily from the day of surgery until day 6. Despite these statistically significant reductions, none of the observed improvements reached the minimum clinically important difference for on the visual analogue scale and no additional benefit was found in resting pain or long-term function [74]. Overall, while duloxetine may offer mild short-term analgesic and opioid-sparing effects, the magnitude of benefit appears clinically negligible when added to an optimised multimodal regimen which includes non-steroidal anti-inflammatory drugs; LIA; and regional techniques.

Carbazochrome sodium sulfonate, administered in combination with tranexamic acid, modestly reduced early postoperative pain and inflammatory markers compared with tranexamic acid alone, but the difference in pain scores was small, transient and of uncertain clinical relevance [75]. No data on opioid consumption or pain at rest were reported and routine multimodal analgesia was incompletely described. Therefore, while carbazochrome sodium sulfonate may have an anti-inflammatory effect, current evidence does not justify its inclusion for analgesic purposes in THA.

Melatonin and pregabalin both reduced postoperative pain compared with placebo, with pregabalin showing slightly greater effect beyond the first few postoperative hours [76]. However, differences remained below the threshold for clinical importance difference, and no opioid-sparing benefit or safety evaluation was provided. Given these limitations and the known adverse-effect profile of pregabalin (e.g. sedation, dizziness), neither drug can be recommended for peri-operative analgesia in THA.

Dexmedetomidine, tested as an opioid-sparing anaesthetic adjunct in an opioid-free anaesthesia regimen, provided no meaningful reduction in postoperative pain or opioid use compared with standard opioid-based anaesthesia [77]. Analgesic differences were minimal and did not show clear clinical benefit, indicating that dexmedetomidine adds little to well-structured multimodal analgesia.

Operative techniques

Among surgical approaches, alternative minimally invasive techniques such as SuperPATH or direct anterior approach have not consistently showed analgesic or functional superiority over standard posterolateral or lateral techniques

[78–82]. The SuperPATH approach showed inconsistent results across studies; some reported higher early postoperative pain and longer operative times, while others observed only minimal or late differences that were not clinically significant [78, 79]. A recent meta-analysis confirms these findings [80]. Similarly, evidence on direct anterior approach remains inconclusive; some trials suggest slightly lower pain during early rehabilitation, but differences remain below minimal clinical important difference and are not accompanied by improved opioid use or recovery [81, 82]. Collectively, these findings indicate that surgical innovations do not provide clinically meaningful improvements in pain, opioid use or recovery when added to an already optimised multimodal analgesic regimen.

Non-pharmacological interventions

A three-dimensional immersive virtual reality for postoperative relaxation or distraction failed to improve pain or reduce opioid consumption when compared with standard video presentations [83]. The absence of measurable benefit indicates that virtual reality-based interventions currently have no role in THA pain management.

Discussion

This review supports a procedure-specific multimodal analgesic strategy for THA centred on motor-sparing regional techniques integrated with basic systemic analgesia. The updated recommendations are summarised in Table 1, while interventions not supported by current evidence are presented in Table 2. Changes compared with the previous PROSPECT recommendations are outlined in Table 3. A qualitative positioning of the principal analgesic techniques according to expected analgesic efficacy and motor-sparing profile is provided in Figure 2.

The strength of this study stems from the PROSPECT methodology, which goes beyond making recommendations based on the simple statistical analysis of the available evidence. The included studies were interpreted in the context of standard multimodal analgesia (paracetamol with non-steroidal anti-inflammatory drugs or COX-2 inhibitors), with recommendations based on the balance between analgesic efficacy, adverse effects and clinical applicability. This approach emphasises functional recovery and early mobilisation, which are central to modern short-stay and day-case THA pathways.

The first 24 h after surgery represent a critical period during which pain intensity peaks and has the greatest impact on early ambulation, opioid consumption and functional recovery [5]. Effective multimodal analgesia during this window is therefore essential to achieve the goals of enhanced recovery and ambulatory arthroplasty pathways. The typical postoperative pain trajectory after THA is characterised by an early sharp peak within the first day and a rapid decline, thereafter, making continuous peripheral nerve blocks unnecessary in most cases [5].

Among regional techniques, proximal anterior motor-sparing approaches – particularly supra-inguinal FICB and pre-operative PENG block – should be prioritised within multimodal analgesia for THA. Conversely, infra-inguinal

Table 3 Summary of differences and similarities between the original and updated PROSPECT review in recommended interventions for pain management in patients undergoing primary total hip arthroplasty.

Intervention	Original PROSPECT review 2021	Updated PROSPECT review 2026
Pre-operative and intra-operative		
Paracetamol and conventional nonsteroidal anti-inflammatory drug or cyclooxygenase-2 selective inhibitor	✓	✓
Dexamethasone	✓	✓
Single shot supra-inguinal fascia iliaca block	✓*	✓
Single shot pericapsular nerve group block	X	✓
Local infiltration analgesia if regional blocks are not possible or contraindicated	✓	✓
Intrathecal morphine 0.1 mg may be considered	✓	✓
Postoperative		
Paracetamol and conventional nonsteroidal anti-inflammatory drug or cyclooxygenase-2 selective inhibitor	✓	✓
Opioids as rescue analgesia	✓	✓

*In the 2021 PROSPECT review, `fascia iliaca block´ referred to all approaches (infra- and suprainguinal) without distinction.

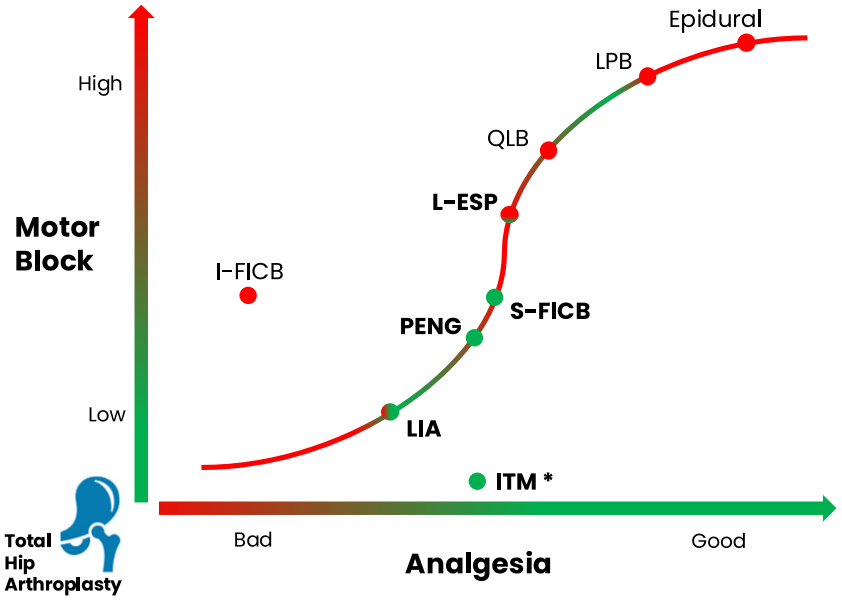

Figure 2 Qualitative positioning of analgesic techniques for primary total hip arthroplasty. Regional analgesic techniques and intrathecal morphine are positioned qualitatively according to their expected balance between motor block (vertical axis) and overall analgesic efficacy (horizontal axis). Motor-sparing techniques such as supra-inguinal fascia iliaca compartment block (supra-FICB), pericapsular nerve group (PENG) block and single-shot local infiltration analgesia (LIA) cluster toward the `good analgesia/low motor block´ quadrant, whereas lumbar plexus block (LPB), quadratus lumborum block (QLB), lumbar erector spinae plane (lumbar ESP) block and epidural analgesia provide effective analgesia at the cost of greater motor impairment. *Low-dose intrathecal morphine (≤ 0.1 mg) is largely motor-sparing but is recommended only when spinal anaesthesia is used and in the inpatient setting, where appropriate postoperative monitoring can be ensured.

FICB is not recommended given the lack of analgesic benefits. This revision from the 2020 guidance reflects accumulating clinical evidence of inconsistent analgesia with infra-inguinal FICB (Table 1). Also, postoperative use of PENG block is not recommended due to insufficient incremental efficacy.

The innervation of the hip joint is complex, arising from both the lumbar and sacral plexuses and supplying distinct anterior and posterior sensory territories. The anterior capsule is mostly relevant for analgesia as it is rich in nociceptors: it conveys pain during surgical exposure and the early postoperative period and receives articular branches primarily from the femoral nerve, obturator nerve, and, when present, the accessory obturator nerves (observed in approximately 30% of individuals) [84, 85]. These branches typically originate above the inguinal ligament, within the pelvis or at the level of the iliopsoas compartment, before coursing distally to innervate the anterior joint capsule.

Anatomical and imaging studies have clarified why infra-inguinal techniques frequently fail to provide effective analgesia after THA [84]. In contrast, supra-inguinal and pericapsular approaches achieve cephalad spread within the iliac fossa, covering the femoral nerve and lateral femoral cutaneous nerve and, inconsistently, the obturator nerve. Consequently, effective postoperative analgesic techniques should prioritise blockade of these proximal articular branches above the inguinal ligament [84–87]. These anatomical insights arguably explain why supra-inguinal FICB and PENG block achieve more consistent and clinically relevant analgesia than infra-inguinal FICB. Importantly, efficacy appears timing-dependent for PENG block: pre-operative administration optimises block onset and diffusion, while postoperative or intra-operative performance yields inconsistent results.

Of note, supra-inguinal FICB, by its very nature, may involve the femoral nerve, which suggests the potential for some degree of motor blockade. However, this concern is not clinically relevant as the included studies report early functional recovery with supra-inguinal FICB [22, 88]. In fact, pain rather than quadriceps weakness is probably the main factor associated with delayed ambulation, orthostatic intolerance, falls and poorer functional performance after THA [6].

Beyond individual trial findings, several recent meta-analyses have supported the role of the PENG block as an

effective component of multimodal analgesia for THA, although heterogeneity in study design and comparator techniques warrants cautious interpretation [88–92]. Importantly, the extent to which the PENG block is truly motor sparing remains uncertain. While designed to minimise quadriceps involvement, emerging evidence suggests that some degree of early motor impairment may occur, likely reflecting unintended spread to the femoral nerve [22]. However, this effect appears transient and has not been consistently associated with delayed mobilisation or impaired functional recovery. From a technical perspective, injectate volume may play a key role in balancing analgesic efficacy and motor preservation. Anatomical and imaging studies suggest that lower volumes (approximately 13 ml) may reduce the risk of femoral nerve involvement, although the optimal volume for achieving consistent analgesia without motor compromise remains to be clearly defined [93].

Recent three-dimensional imaging work has further refined the anatomical understanding of this block, showing that injectate tends to remain confined within the iliopsoas fascial compartment, with limited capsular spread and inconsistent diffusion toward the obturator plane [94]. Furthermore, a recent cadaveric study, although limited in scope, has shown that, even with high injection volumes of up to 30 ml, the obturator nerve is inconsistently stained, confirming that this structure is unlikely to be reliably anesthetised by the PENG block [95]. Nonetheless, a volume of approximately 30 ml appears necessary to achieve consistent spread to the femoral and accessory obturator nerves in most specimens. Conversely, another anatomical study estimated that the volume required to achieve a femoral-sparing PENG block in 90% of samples was 13.2 ml, lower than the doses typically used in clinical trials and current practice (15–20 ml) [93]. These findings suggest that the analgesic effect may primarily result from blockade of femoral nerve branches rather than true pericapsular infiltration.

Posterior fascial plane techniques, including lumbar ESP and QLB, do not appear to provide a clinically meaningful advantage within contemporary multimodal analgesia for THA. Evidence to date does not support their superiority over established motor-sparing anterior approaches, and recent systematic reviews and meta-analyses have confirmed the absence of consistent clinical benefit across different QLB techniques [96–98]. In addition, concerns related to unintended lumbar plexus spread, motor impairment and rare (but potentially serious) complications further limit their role, particularly in enhanced recovery pathways where early mobilisation is prioritised. Taken together, these considerations do not support the routine use of QLB – irrespective of approach – within the updated PROSPECT framework.

Local infiltration analgesia, performed intra-operatively by the surgeon, represents a pragmatic and technically simple option, particularly when regional anaesthesia is not feasible or contraindicated. However, its overall benefit appears modest and context-dependent, and it does not consistently improve pain, opioid use or functional recovery beyond what can be achieved with preferred motor-sparing regional techniques. Continuous LIA is not supported, as it does not appear to provide additional clinically relevant benefit and may increase the risk of complications, including infection [53–55].

Although both supra-inguinal FICB and PENG are associated with a potential risk of postoperative quadriceps weakness [20, 22], they remain the preferred regional techniques owing to their superior, more consistent and longer lasting analgesia. A recent network meta-analysis supports this approach [99]. Local infiltration analgesia may be considered an acceptable component of multimodal analgesia when regional anaesthesia expertise is lacking or contraindicated. Of note, it is possible that the use of supra-inguinal FICB and PENG block may be beneficial in patients at high risk of postoperative pain (high pain responders) and in patients in whom basic analgesics are contraindicated, although the evidence for this assertion is lacking.

There is currently no good evidence supporting the combination of these regional techniques (e.g. supra-inguinal FICB, PENG or lumbar ESP) with LIA. The combination does not enhance postoperative analgesic outcomes and may, on the contrary, expose patients to higher and potentially toxic concentrations of local anaesthetic. In fact, this approach would result in a redundant dual analgesia targeting the anterior nociceptive component of the joint capsule, with the LIA adding only limited benefit for the posterior capsule, which plays a minor role in nociception [85, 86]. A recent network meta-analysis comparing motor-sparing fascial plane blocks and infiltration techniques for THA reported that LIA achieved the highest ranking for 24-h rest pain, whereas the QLB was superior in reducing opioid consumption [100]. However, in this study, different techniques of LIA were grouped together under a single mode without standardisation of injectate composition or timing, and the supra-inguinal FICB was explicitly and somewhat questionably excluded a priori. Moreover, the results appear methodologically fragile, given the high heterogeneity among included studies and the divergent findings across pain and opioid

consumption outcomes. These limitations substantially restrict the applicability of the conclusions to current PROSPECT methodology, in which regional blocks are analysed separately and evaluated based on consistent, clinically relevant and procedure-specific criteria.

Among neuraxial adjuncts, intrathecal morphine remains the only agent supported by consistent procedure-specific evidence in THA. It may be considered as an alternative to peripheral regional techniques in selected inpatient settings, although its use in ambulatory pathways may be limited by monitoring requirements and adverse effects [101].

Systemic corticosteroids, particularly dexamethasone, remain a key component of multimodal analgesia in THA, with consistent evidence supporting their beneficial effects on pain, recovery and postoperative symptoms. Future studies are recommended to investigate multiple administrations, different timings and the effect of split doses.

Despite rapid procedural evolution, no novel surgical or non-pharmacological approach has shown a reproducible impact on postoperative analgesia, reinforcing the central role of pharmacologic and regional multimodal strategies.

While the PROSPECT framework provides a pragmatic, procedure-specific approach to analgesic recommendations, several inherent limitations should be acknowledged. First, its selective evidence inclusion – restricting analysis to randomised controlled trials – excludes potential valuable data from pragmatic or real-world studies. This can lead to overestimation of efficacy under ideal conditions and limited external validity, particularly for interventions requiring surgical or anaesthetic expertise [3]. Second, no formal meta-analysis could be performed. Although this maintains focus on clinical applicability, it precludes pooled estimates of effect size, hindering the capacity to rank interventions quantitatively or assess comparative superiority. Heterogeneity among included studies – arising from variable designs, endpoints and multimodal regimens – further complicates synthesis and interpretation. Third, delayed updates and rapidly evolving evidence represent practical challenges. The time lag between literature cut-off and publication may result in recommendations that are not fully updated upon release, particularly in rapidly advancing domains such as regional anaesthesia. Fourth, the reliance on expert consensus in areas with limited evidence introduces subjectivity. When data are inconsistent or sparse, recommendations may reflect expert interpretation rather than robust, reproducible evidence. This is compounded by cognitive biases inherent to clinical judgment – anchoring, confirmation or publication bias – which can subtly shape consensus outcomes. Statistical limitations also undermine the reliability of some included trials. Fifth, many studies in pain research treat repeated measures of visual analogue scale or numerical rating scale scores as independent observations, disregarding their longitudinal correlation and leading to inflated type 1 error rates [102]. Underestimation of variance, loss of within-subject information and small sample sizes further contribute to overstatement of effect magnitude and reproducibility issues [103, 104]. As a result, even statistically significant results often fail to meet thresholds for clinical relevance. Finally, PROSPECT recommendations are constrained by limited high-quality randomised controlled trials per procedure, heterogeneous study design and the lack of placebo or relevant comparators in many fields. As pain medicine evolves, reliance on expert judgment remains inevitable, but greater integration of pragmatic data, advanced statistical modelling (e.g. mixed-effects models) and living systematic review methodologies could enhance precision and timeliness of updates.

Future research should comprise adequately powered, high-quality randomised trials directly comparing contemporary regional techniques – including supra-inguinal FICB, PENG and LIA – all on top of a basic multimodal analgesic regimen with peri-operative dexamethasone. Beyond analgesic efficacy during first 24 h postoperatively, studies must assess motor-sparing effects through functional outcomes moving beyond quadriceps strength alone to performance-based mobility (early ambulation, readiness for discharge and time to return to usual activities) and include prespecified patient-reported outcome measures. Statistical analysis should use longitudinal methods capable of handling repeated measures and missing data. Preregistration, CONSORT-aligned reporting and standardised rescue analgesia will further enhance interpretability and comparability across trials.

The present review refines the evidence-based trajectory of analgesia for THA within the modern multimodal, motor-sparing paradigm. The recommendations are basically valid for the average surgical patient for THA. In patients with contraindications to one or more of the recommended measures or in patients with expectations of stronger pain than average, additional analgesic measures may be needed. Also, these results should not be interpreted as static endpoints but as evolving evidence within a dynamic clinical landscape. The rapid development of novel interfascial blocks and imaging-guided refinements underscores the need for continual reappraisal of efficacy,

safety and functional outcomes. Moreover, the increasing prevalence of same-day and ambulatory THA mandates further evaluation of motor-sparing regional techniques optimised for early discharge pathways. Ultimately, the goal remains to balance potent analgesia with rapid rehabilitation and minimal adverse effects – principles central to enhanced recovery after surgery. By integrating anatomical understanding, high-quality evidence and pragmatic methodology, updated procedure-specific recommendations can continue to refine peri-operative care for THA.

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Supporting Information

Additional supporting information may be found online via the journal website.

Appendix S1. Detailed electronic search strategy.

Table S1. Studies not included.

Figure S1. Risk of bias assessment of included trials using the Cochrane Risk of Bias 2 tool.