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Nerve blocks or no nerve blocks for pain control after elective hip replacement (arthroplasty) surgery in adults (Review)

Guay J, Johnson RL, Kopp S

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Nerve blocks or no nerve blocks for pain control after elective hip replacement (arthroplasty) surgery in adults (Review)

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[Intervention Review]

Nerve blocks or no nerve blocks for pain control after elective hip replacement (arthroplasty) surgery in adults

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ABSTRACT

Background

It is estimated that over 300,000 total hip replacements are performed each year in the USA. For European countries, the number of hip replacement procedures per 100,000 people performed in 2007 varied from less than 50 to over 250. To facilitate postoperative rehabilitation, pain must be adequately treated. Peripheral nerve blocks and neuraxial blocks have been proposed to replace or supplement systemic analgesia.

Objectives

We aimed to compare the relative effects (benefits and harms) of the different nerve blocks that may be used to relieve pain after elective hip replacement in adults.

Search methods

We searched the Cochrane Central Register of Controlled Trials (CENTRAL, Issue 12, 2016), MEDLINE (Ovid SP) (1946 to December Week 49, 2016), Embase (Ovid SP) (1980 to December week 49, 2016), CINAHL (EBSCO host) (1982 to 6 December 2016), ISI Web of Science (1973 to 6 December 2016), Scopus (from inception to December 2016), trials registers, and relevant web sites.

Selection criteria

We included all randomized controlled trials (RCTs) performed in adults undergoing elective primary hip replacement and comparing peripheral nerve blocks to any other pain treatment modality. We applied no language or publication status restrictions.

Data collection and analysis

Data were extracted independently by two review authors. We contacted study authors.

Main results

We included 51 RCTs with 2793 participants; of these 45 RCTs (2491 participants: peripheral nerve block = 1288; comparators = 1203) were included in meta-analyses. There are 11 ongoing studies and three awaiting classification.

Compared to systemic analgesia alone, peripheral nerve blocks reduced: pain at rest on arrival in the postoperative care unit (SMD -1.12, 95% CI -1.67 to -0.56; 9 trials, 429 participants; equivalent to 3.2 on 0 to 10 scale; moderate-quality evidence); risk of acute confusional status: risk ratio (RR) 0.10 95% CI 0.02 to 0.54; 1 trial, 225 participants; number needed to treat for additional benefit (NNTB) 12, 95% CI 11 to 22; very low-quality evidence); pruritus (RR 0.16, 95% CI 0.04 to 0.70; 2 trials, 259 participants for continuous peripheral nerve blocks; NNTB

4 (95% CI 4 to 8); very low-quality evidence); hospital length of stay (SMD -0.75, 95% CI -1.02 to -0.48; very low-quality evidence; 2 trials, 249 participants; equivalent to 0.75 day). Participant satisfaction increased (SMD 0.67, 95% CI 0.45 to 0.89; low-quality evidence; 5 trials, 363 participants; equivalent to 2.4 on 0 to 10 scale). We did not find a difference for the number of participants walking on postoperative day one (very low-quality evidence). Two nerve block-related complications were reported: one local haematoma and one delayed persistent paresis.

Compared to neuraxial blocks, peripheral nerve blocks reduced the risk of pruritus (RR 0.33, 95% CI 0.19 to 0.58; 6 trials, 299 participants; moderate-quality evidence; NNTB 6 (95% CI 5 to 9)). We did not find a difference for pain at rest on arrival in the postoperative care unit (moderate-quality evidence); number of nerve block-related complications (low-quality evidence); acute confusional status (very low-quality evidence); hospital length of stay (low quality-evidence); time to first walk (low-quality evidence); or participant satisfaction (high-quality evidence).

We found that peripheral nerve blocks provide better pain control compared to systemic analgesia with no major differences between peripheral nerve blocks and neuraxial blocks. We also found that peripheral nerve blocks may be associated with reduced risk of postoperative acute confusional state and a modest reduction in hospital length of stay that could be meaningful in terms of cost reduction considering the increasing numbers of procedures performed annually.

Authors' conclusions

Compared to systemic analgesia alone, there is moderate-quality evidence that peripheral nerve blocks reduce postoperative pain, low-quality evidence that patient satisfaction is increased and very low-quality evidence for reductions in acute confusional status, pruritus and hospital length of stay .

We found moderate-quality evidence that peripheral nerve blocks reduce pruritus compared with neuraxial blocks.

The 11 ongoing studies, once completed, and the three studies awaiting classification may alter the conclusions of the review once assessed

PLAIN LANGUAGE SUMMARY

Peripheral nerve blocks compared to other types of pain relief for people having total hip joint replacement surgery

Background

Controlling pain after hip replacement surgery improves comfort and improves participation in rehabilitation. These aspects help people to return home sooner and limit treatment costs.

Peripheral nerve block is a treatment for pain control that involves injecting local anaesthetic around nerves to block or stop the sensation of pain reaching the brain. A neuraxial block is an injection of local anaesthetic in the spine through a needle or catheter (very thin, small tube) to block pain transmission from the spine to the brain.

We evaluated the benefits and harms of nerve blocks compared to no nerve blocks or other forms of pain relief to following hip replacement in adults.

Search dates

We searched to December 2016.

Study characteristics

We included 51 studies (2793 participants) in the review and analysed results from 45 studies (2491 participants). There are 11 ongoing studies and three awaiting classification.

Study funding sources

Funding sources included governments, charities, institutions, industry (in part, n = 1); over half were unspecified (n = 29).

Key results

Compared to systemic analgesia, we found that peripheral nerve blocks reduce pain, reduce the risk of becoming confused (e.g. not knowing the date, time, or location) (for every 12 people treated one fewer will become confused), reduce itching (for every 4 people treated one fewer will develop itch), hospital length of stay (equivalent to 0.75 day) and increase patient satisfaction for pain treatment (equivalent to 2.4 points more on a 0 to 10 scale). We did not find a difference in time to first walk after surgery.

Two people had complications: one local haematoma and one delayed persistent muscle weakness.

Quality of evidence

The quality of evidence for peripheral nerve blocks compared with systemic pain relievers was rated as moderate to very low.

The quality of evidence for peripheral nerve blocks compared to neuraxial blocks was rated as high for patient satisfaction, moderate for reducing itch, similar pain relief, low for similar block-related complications, hospital length of stay and time to first walk. Evidence for confusion was assessed as very low quality.

Evidence quality was downgraded to low or very low due to flawed study designs and limited numbers of trials and participants.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Peripheral nerve blocks compared to systemic analgesia for elective primary total hip replacement

Peripheral nerve blocks compared to systemic analgesia for elective primary total hip replacement

Patient or population: adults undergoing elective primary total hip replacement

Settings: trials were performed in Australia, Australia and UK, Belgium (n = 4), Belgium, France and Switzerland, Belgium and USA, Bosnia and Herzegovina, Brazil, Bulgaria and France, China (n = 2), Denmark (n = 3), Egypt, Egypt and Japan, France (n = 2), Germany (n = 4), India, Ireland, Italy (n = 3), Japan (n = 2), Lithuania, New Zealand, Romania, Russia, Serbia, Spain, Switzerland (n = 2), Turkey (n = 4), UK (n = 4), UK and Australia, USA (n = 2).

Intervention: Peripheral nerve blocks

Comparison: systemic analgesia

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Systemic analgesia	Peripheral nerve blocks				
Pain at rest on arrival in postoperative care unit Visual/verbal analogue scale	CD	The mean pain at rest on arrival in postoperative care unit in the intervention groups was 1.12 standard deviations lower (1.67 to 0.56 lower)	SMD -1.12 (-1.67 to -0.56)	429 (9 studies)	⊕⊕⊕⊖ moderate ¹	Equivalent to 3.2 on a scale from 0 to 10
Total number of nerve block-related complications	NA	1 local haematoma 1 delayed paresis	NA	NA	NA	Examples: erythema, damage to surrounding structures, allergic reactions, infections, transient and lasting neurological damage
Acute confusional state Complete loss of time and space orientation Follow-up: 0 to 30 days	Study population		RR 0.10 (0.02 to 0.54)	225 (1 study)	⊕⊖⊖⊖ very low ²	Number needed to treat for additional benefit: 12 (95% CI 11 to 22)
	133 per 1000	13 per 1000 (3 to 72)				
	Low					
	50 per 1000	5 per 1000 (1 to 27)				
	High

	150 per 1000	15 per 1000 (3 to 81)				
Pruritus Follow-up: 0 to 2 days	Study population		RR 0.16 (0.04 to 0.70)	259 (2 studies)	⊕⊕⊕⊕ very low ³	Continuous peripheral nerve blocks only Number needed to treat for additional benefit: 4 (95% CI 4 to 8)
	161 per 1000	26 per 1000 (6 to 113)				
	Low					
	50 per 1000	8 per 1000 (2 to 35)				
	High					
	250 per 1000	40 per 1000 (10 to 175)				
Hospital length of stay Objective actual measurement Follow-up: 0 to 30 days	CD	The mean hospital length of stay in the intervention groups was 0.75 standard deviations lower (1.02 to 0.48 lower)	SMD 0.75 (-1.02 to -0.48)	249 (2 studies)	⊕⊕⊕⊕ very low ⁴	Continuous peripheral nerve blocks only Equivalent to 0.75 day
Walking at postoperative day 1 Objective actual measurement Follow-up: median 1 days	Number of participants walking at postoperative day 1	The risk difference was 0.01 (-0.03 to 0.05)	RD 0.01 (-0.03 to 0.05)	278 (2 studies)	⊕⊕⊕⊕ very low ⁵	One trial evaluated effect with single injection block and the other with continuous peripheral nerve block
Patient satisfaction Subjective scales Follow-up: 0 to 30 days	CD	The mean patient satisfaction in the intervention groups was 0.67 standard deviations higher (0.45 to 0.89 higher)	SMD 0.67 (0.45 to 0.89)	363 (5 studies)	⊕⊕⊕⊕ low ⁶	Equivalent to 2.4 on a scale from 0 to 10

The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio; **NA:** Not applicable; because blocks were performed in the intervention group only and not in the control group, a relative risk could not be calculated; **CD:** continuous data analysed as standardized mean difference, mean clinical value of control groups not available

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

- ¹ Downgraded one level due to serious concerns about study limitations
- ² Downgraded four levels due to very serious concerns about study limitations and very serious concerns about imprecision
- ³ Downgraded three levels due to very serious concerns about study limitations and serious concerns about imprecision
- ⁴ Downgraded three levels due to very serious concerns about study limitations and serious concerns about imprecision
- ⁵ Downgraded three levels due to very serious concerns about study limitations and serious concerns about imprecision
- ⁶ Downgraded two levels due to very serious concerns about study limitations

Summary of findings 2. Peripheral nerve block compared to neuraxial block for elective primary total hip replacement

Peripheral nerve block compared to neuraxial block for elective primary total hip replacement

Patient or population: adults undergoing elective primary total hip replacement

Settings: trials were performed in Australia, Australia and UK, Belgium (n = 4), Belgium, France and Switzerland, Belgium and USA, Bosnia and Herzegovina, Brazil, Bulgaria and France, China (n = 2), Denmark (n = 3), Egypt, Egypt and Japan, France (n = 2), Germany (n = 4), India, Ireland, Italy (n = 3), Japan (n = 2), Lithuania, New Zealand, Romania, Russia, Serbia, Spain, Switzerland (n = 2), Turkey (n = 4), UK (n = 4), UK and Australia, USA (n = 2).

Intervention: peripheral nerve block

Comparison: neuraxial block

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Neuraxial block	Peripheral nerve block				
Pain at rest on arrival in postoperative care unit Verbal/visual analogue scale. Scale from: 0 to 10	Visual/verbal analogue scale from 0 to 10	The mean pain at rest on arrival in postoperative care unit in the intervention groups was 0.39 higher (0.15 lower to 0.94 higher)	SMD 0.39 (-0.15 to 0.94)	118 (4 studies)	⊕⊕⊕⊖ moderate ¹	
Total number of block-related complications	Study population		RD 0 (-0.05 to 0.05)	334 (5 studies)	⊕⊕⊖⊖ low ²	
	48 per 1000	48 per 1000 (46 to 50)				
	Low					
	10 per 1000	10 per 1000 (9 to 11)				
	High					
	100 per 1000	100 per 1000				

	(95 to 105)					
Auto confusional state Disorientation Follow-up: 0 to 2 days	Study population		RR 0.29 (0.01 to 6.69)	50 (1 study)	⊕⊕⊕⊕ very low ³	
	43 per 1000	13 per 1000 (0 to 291)				
	Low					
	25 per 1000	7 per 1000 (0 to 167)				
	High					
	150 per 1000	43 per 1000 (1 to 1000)				
Pruritus Subjective scale Follow-up: 0 to 7 days	Study population		RR 0.33 (0.19 to 0.58)	299 (6 studies)	⊕⊕⊕⊕ moderate ⁴	Number needed to treat for additional benefit: 6 (95% CI 5 to 9)
	258 per 1000	88 per 1000 (49 to 152)				
	Low					
	50 per 1000	17 per 1000 (9 to 29)				
	High					
	300 per 1000	102 per 1000 (57 to 177)				
Hospital length of stay	The mean hospital length of stay in the control groups was 12.6 days*	The mean hospital length of stay in the intervention groups was 0.19 higher (0.39 lower to 0.77 higher)	MD 0.19 (-0.39 to 0.77)	64 (2 studies)	⊕⊕⊕⊕ low ⁵	
Time to first walk	The mean time to first walk in the control groups was 3.3 days*	The mean time to first walk in the intervention groups was 0.41 lower (1.09 lower to 0.27 higher)	MD -0.41 (-1.09 to 0.27)	94 (3 studies)	⊕⊕⊕⊕ low ⁶	
Patient satisfaction	CD	The mean patient satisfaction in the intervention groups was 0.08 standard deviations higher	SMD 0.08 (-0.32 to 0.48)	307 (6 studies)	⊕⊕⊕⊕ high ⁷	

(0.15 lower to 0.31 higher)

The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio; **CD:** continuous data analysed as standardized mean difference, mean clinical value of control groups not available; * individual participants data not available therefore tests for distribution normality could not be done.

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

- 1 Downgraded one level due to serious concerns about study limitations
- 2 Downgraded two levels due to very serious concerns about imprecision
- 3 Downgraded three levels due to serious concerns about study limitations and very serious concerns about imprecision
- 4 Downgraded one level due to serious concerns about study imprecision
- 5 Downgraded two levels due to serious concerns about study limitations and serious concerns about imprecision
- 6 Downgraded two levels due to serious concerns about study limitations and serious concerns about imprecision
- 7 Not downgraded

BACKGROUND

Description of the condition

Total hip replacement (arthroplasty) is one of the most successful orthopaedic operations performed for intractable hip pain due to primary and secondary osteoarthritis, osteonecrosis, and rheumatoid arthritis. It is estimated that over 300,000 total hip replacements are performed each year in the USA alone. For European countries, the number of hip replacement procedures performed in 2007 varied from fewer than 50 to over 250 per 100,000 people (WHO 2011). Controlling pain after a hip replacement improves patient comfort and satisfaction and enables patients to participate in rehabilitation more fully, leading to an earlier return home and reduced demand on resources. Current methods of pain control following hip replacement surgery include:

1. systemic opioids or other analgesics;
2. neuraxial blocks (epidural analgesia);
3. peri-articular/intra-articular analgesia; and
4. nerve blocks (psoas compartment block, femoral block, fascia iliaca compartment block, combined nerve blocks).

Pain after hip replacement has traditionally been managed using systemic pain medications including acetaminophen (paracetamol), non-steroidal anti-inflammatory drugs (NSAIDs) and opioid analgesics. The use of parenteral or oral opioids is associated with significant adverse effects including nausea, vomiting, constipation, drowsiness, and confusion; all may affect recovery and satisfaction and prolong hospital stays.

Central neuraxial blocks provide effective pain control, but there is a higher risk of neurologic complications (transient paraesthesia, motor blockade, seizures) (Auroy 1997; Türker 2003), cardiovascular complications necessitating haemodynamic monitoring (intra-operative hypotension, postural hypotension, cardiac arrest) (Auroy 1997), pruritus (itch), nausea and vomiting (Horlocker 1998), and urinary retention with central neuraxial blocks compared to peripheral nerve blocks (Horlocker 1998; Fischer 2005). Epidural anaesthesia for non-obstetric indications has sometimes been associated with a risk of epidural haematoma (Volk 2012). The risk factors predisposing to epidural haematoma, such as higher age, renal insufficiency, and use of anticoagulants, are very common in people undergoing hip replacement. Central neuraxial blocks in people who are anticoagulated increase the risk of epidural/spinal haematoma that may result in permanent neurological damage (Dahlgren 1995; Sternlo 1995). Elderly people undergoing hip replacements may have spinal stenosis, which may increase the risk of neurological complications with central neuraxial blocks (Hebl 2010). A prior Cochrane review studied epidural analgesia for pain relief following hip or knee replacement (Choi 2003).

Peri-articular analgesia (injecting various combinations of local anaesthetics and analgesics into the hip joint or periarticular tissues) has gained popularity recently. A Cochrane Review protocol has been published on this topic (Hadi 2014).

Because peripheral nerve blocks confine anaesthesia to the surgical region, many disadvantages of neuraxial blocks can be avoided. Peripheral nerve damage can occur after peripheral nerve block, but consequences may be more limited than with central neuraxial blocks. Given the significant differences in safety profiles

of peripheral nerve blocks and central neuraxial blocks, we focused specifically on peripheral nerve blocks.

Description of the intervention

Nerve blocks (injection of a local anaesthetic around a nerve) relieve pain by interrupting transmission of pain signals from the peripheral nerves. Nerve blocks for orthopaedic procedures have been shown to facilitate the execution of surgery in ambulatory surgery (day surgery), improve pain control and sleep after surgery, and decrease time to discharge home (Ilfeld 2006a; Ilfeld 2006b). Nerve blocks may also reduce the need for systemic pain medications limiting associated adverse effects.

How the intervention might work

The hip area is innervated by branches of the lumbar plexus. The hip joint is supplied with femoral and obturator nerves, nerve to quadratus femoris, superior gluteal and sciatic nerves. The dermatomal supply of the hip joint is typically from spinal nerve roots lumbar-4 to as low as sacral-2. The bony structures of the hip joint are supplied from spinal nerve roots lumbar-3 to sacral-1. It is difficult to achieve complete pain relief of the hip with peripheral nerve blocks (de Visme 2000), and some techniques (psoas compartment block) are considered to be expert-level (practiced only by some anaesthesiologists; Hargett 2005). There are many types and techniques for blocking the lumbar plexus nerves following hip replacement.

1. Lumbar plexus, or psoas compartment block: peripheral regional anaesthetic technique to block the major nerves of the lumbar plexus (femoral, lateral femoral cutaneous and obturator nerves) in the psoas major muscle (Chayen 1976; Capdevila 2002; Karmakar 2015).
2. Femoral nerve block is a safe and widely practiced local anaesthetic technique used to supplement anaesthesia and provide postoperative analgesia after hip surgery (Szucs 2010; Winnie 1973). Local anaesthetic is infiltrated around the femoral nerve, which provides anaesthesia to the anterior thigh (femoral nerve) and the medial lower leg (through the saphenous nerve). However, the cephalad spread of the local anaesthetic may not be sufficient to block the obturator nerve (medial thigh) and the lateral cutaneous nerve of thigh (Marhofer 2000).
3. Fascia iliaca compartment block (FICB) is an anterior-thigh regional anaesthetic block targeting the lumbar plexus (Dalens 1989; Murgatroyd 2013). This block was initially described by Dalens 1989 for children where sensory blockade of the obturator nerve was believed to be observed. It was believed the local anaesthetic spread underneath the fascia iliaca proximally towards the lumbosacral plexus (Dalens 1989). However, it has since been discovered that nearly half of patients do not have a skin component of the obturator nerve and that assessing adductor strength is the only effective way to measure obturator nerve function (Bouaziz 2002). Kaloul 2004 found that motor obturator nerve blockade is achieved in fewer than 50% of patients undergoing femoral nerve blocks. The effect of the FICB is similar to the femoral nerve block, but may provide a more reliable method of reaching the femoral lateral cutaneous nerve.
4. It is possible to individually block nerves supplying the hip, but this is time consuming.

Why it is important to do this review

Nerve blocks have been used successfully to reduce opioid requirements following other surgical interventions. A Cochrane Review has been published that investigated adding peripheral nerve blocks for hip fracture surgery ([Guay 2017](#)). Several RCTs have reported on the use of nerve blocks for pain control after hip replacement. A Cochrane Review focusing on functional improvement with regional analgesia at 3, 6, or 12 months after hip, knee, or shoulder replacement is available ([Atchabahian 2015](#)).

This review aimed to provide evidence to assist people undergoing hip replacement to decide which pain management protocol to choose and whether the risks associated with having nerve blocks exceed the benefits.

The rapidly rising volume of hip replacement surgeries being performed annually worldwide will considerably increase the burden on healthcare resources. A systematic review evaluating the current evidence of the short- and long-term safety and efficacy of nerve blocks after hip replacement surgery was necessary.

OBJECTIVES

We aimed to compare the relative effects (benefits and harms) of the different nerve blocks that may be used to relieve pain after elective hip replacement in adults.

METHODS

Criteria for considering studies for this review

Types of studies

We included all parallel randomized controlled trials (RCTs) comparing different nerve blocks with other pain treatment modalities (control group). We excluded non-RCTs and observational studies.

Types of participants

We included adults aged over 16 years undergoing hip replacement for the first time. We excluded adults undergoing revision hip replacement or hip replacement for acute fractures.

Types of interventions

We included all peripheral nerve blocks: psoas compartment block, femoral nerve block (or 3-in-1 block, fascia iliaca compartment block, obturator nerve block or femoral lateral cutaneous nerve block as the study intervention. For comparators we divided studies according to systemic analgesia, no block or sham block (comparison 1), neuraxial blocks (comparison 2), local anaesthetic infiltration (comparison 3) or intravenous lidocaine infusion (comparison 4).

Types of outcome measures

Primary outcomes

1. Participant-reported pain at rest and with movement on visual analogue scale (VAS), numeric rating scale (NRS), or other similar scales or on ordinal or qualitative scales (FACES).
2. Total number of nerve block-related complications (e.g. erythema, damage to surrounding structures, allergic reactions,

infections, transient and lasting (more than three months) neurological damage).

Secondary outcomes

1. Analgesic requirements: we assessed amount of oral/parental supplemental analgesic needed.
2. Minimal clinically important improvement in pain: we evaluated if the improvement in pain scores (continuous variable) was clinically important (categorical variable). We considered a pain scale improvement of 2 cm with nerve block on a 0 cm to 10 VAS scale as clinically important. We assessed the proportion of participants with pain VAS scale differences of 2 cm on a 0 cm to 10 cm scale as categorical variable.
3. Complications specific to the method of treatment: We assessed for:
 - a. allergic reactions;
 - b. damage to surrounding structures at site of nerve block;
 - c. other complications as detailed in each study.
4. General medical complications within six weeks after surgery: we assessed for the following.
 - a. Gastrointestinal: nausea, vomiting, constipation, ileus.
 - b. Pulmonary: pneumonia, bronchitis.
 - c. Cardiovascular: hypotension, myocardial infarction, blood loss and blood transfusion.
 - d. Neurological: acute confusional state, drowsiness, cerebrovascular accident, postoperative cognitive dysfunction.
 - e. Thromboembolic complications: deep vein thrombosis or pulmonary embolism.
 - f. Other medical complications: pruritus, respiratory depression or other.
5. Use of resources. We assessed:
 - a. length of hospital stay;
 - b. costs of treatment;
 - c. re-hospitalization due to pain;
 - d. re-hospitalization due to any other reason, including re-operation.
6. Quality of life, assessed with the 36-Item Short Form Health Survey ([Ware 1992](#)), Sickness Impact Profile, or other quality-of-life scales
7. Short-term rehabilitation milestones (within six weeks after surgery), such as
 - a. time to start rehabilitation, e.g. time to sit up in bed; and
 - b. time to achieve rehabilitation milestones, e.g. transfer unassisted in and out of bed and ability to walk unassisted with a walker on a level surface.
8. Patient satisfaction on VAS, NRS, or other similar scales, or on ordinal or qualitative scales (FACES)

Search methods for identification of studies

Electronic searches

We searched the Cochrane Central Register of Controlled Trials (CENTRAL, Issue 12, 2016; [Appendix 1](#)), MEDLINE (Ovid SP; 1946 to December Week 49, 2016; [Appendix 2](#)), Embase (Ovid SP; 1980 to December week 49, 2016; [Appendix 3](#)), CINAHL (EBSCO host; 1982 to 6 December 2016; [Appendix 4](#)), ISI Web of Science (1973

to 6 December 2016; [Appendix 5](#)) and Scopus (from inception to 6 December 2016; [Appendix 6](#)).

We applied no language restriction.

Searching other resources

We searched the following resources in April 2016:

- reference lists of included trials and recent relevant reviews (2012 to 2016);
- trials registers: www.clinicaltrials.gov and [Australian and New Zealand Clinical Trials Register](#);
- Google Scholar;
- [Prospect](#), the Procedure Specific Postoperative Pain Management web site; and
- conference abstracts of the American Society of Anesthesiologists (2004 to 2015), the American Society of Regional Anesthesia (Spring Meetings 2004 to 2016), the European Society of Anaesthesiology (2004 to 2015) and the European Society of Regional Anaesthesia (2004 to 2015).

Data collection and analysis

Selection of studies

Two review authors (JG and RLJ) independently screened the titles and abstracts of publications identified in the literature search for possible inclusion. We obtained the full published manuscripts of clinical trials that appeared to be eligible to assess their relevance based on the prespecified inclusion criteria. We documented reasons for study exclusion. We planned to, but did not need to involve a third review author (SK) to resolve any disagreements regarding study exclusion. Where there was insufficient published information to make a decision about inclusion, we contacted the study authors.

Data extraction and management

Two review authors (JG and SK) independently extracted study data. We resolved any discrepancies in the extracted data by discussion. We planned to, but did not need to involve a third review author (RLJ) to resolve any disagreements. All study authors were contacted to obtain additional information.

Assessment of risk of bias in included studies

Two review authors (JG and SK) assessed each trial independently, without masking of authors or source, for methodology quality ([Higgins 2011](#)). We resolved any discrepancies in extracted data by discussion. We planned to but did not need to involve a third review author (RLJ) to resolve any disagreements.

We assessed each trial for risk of bias based on following parameters: selection bias (random sequence generation and allocation concealment), performance and detection bias (blinding of participants and personnel (healthcare providers) and blinding of outcome assessors), attrition bias (incomplete outcome data) and reporting bias (selective reporting) ([Appendix 7](#)). We rated each of those parameters as low risk, high risk, or unclear risk. We considered the risk of bias as 'unclear' if there was insufficient reporting to permit judgement of low or high risk and made no assumptions.

We also assessed whether studies used intention-to-treat analysis methods ([Hollis 1999](#)).

Measures of treatment effect

For dichotomous variables, we calculated risk ratios (RR) with 95% confidence intervals (CI) or risk difference (RD) (studies with 0 events on both sides). For continuous data, such as pain intensity, we used mean difference (MD) or standardized mean difference (SMD; different scales from one study to another or data extractable as P value only) with 95% CIs. Data extractable only as P value, number of participants and direction were entered using the calculator in RevMan ([Review Manager 2014](#)). Continuous data provided in formats other than mean and SD were extracted as P values, number of participants and direction. For results given as SMD, we calculated a clinical equivalence on a known scale by multiplying the SMD by a typical standard deviation (SD) of one of the studies included in the analysis.

We calculated the number needed to treat for additional benefit (NNTB), or the number needed to treat to harm (NNTH), where appropriate, based on the odds ratio.

Unit of analysis issues

Some trials compared multiple interventions or control groups of interest. Where each arm assessed a different intervention of interest, we analysed the interventions separately in the appropriate meta-analysis. To address issues of double-counting and unit-of-analysis error of the control group resulting from including several correlated comparisons into a meta-analysis, we:

1. excluded subgroups not relevant to the review scope ([Asano 2010](#); [Nishio 2014](#); [Saksena Shrivastava 2011](#));
2. split the control group into two groups (shared) with smaller size and included two reasonably independent comparisons ([Anis 2011](#); [Biboulet 2004](#); [Celidonio 2008](#); [Lončar 2016](#); [Marino 2009](#); [Nicholson 2002](#); [Nishio 2014](#); [Singelyn 2005](#); [Utebey 2009](#)); or
3. combined subgroups to present one comparison (for some of the analysis, split groups were recombined).

We chose to split a subgroup when we thought it would help to explain sources of heterogeneity without adding a risk of introducing small-study effect.

Dealing with missing data

All study authors were contacted. Standard deviations were calculated from standard errors of means but not from quartiles or ranges. Medians were not considered equivalent to means. Data given as exact P values were extracted as such. We made no imputations.

Assessment of heterogeneity

We assessed heterogeneity by visual inspection of forest plots with consideration of the test for heterogeneity (χ^2) and the I^2 statistic ([Higgins 2003](#)).

We assessed clinical heterogeneity of included trials based on their clinical and methodological diversity ('Risk of bias' assessment). Our a priori hypothesis for sources of clinical heterogeneity were:

1. different types of nerve blocks used;

2. different regimens of analgesic agents across trials, i.e. different types of local analgesic drugs, concentrations, sites, and timing of injections (single injection versus continuous catheter technique) used to administer blocks; and
3. different levels of standard co-analgesia across trials.

We presented primary analyses using fixed ($I^2 < 25\%$) or random-effects ($I^2 \geq 25\%$) models. We considered values of $I^2 \geq 25\%$ to represent significant between-study heterogeneity (Higgins 2003). If significant heterogeneity existed ($I^2 \geq 25\%$), we explored the data according to our predefined criteria for heterogeneity exploration with meta-regression or subgrouping as appropriate. We also used sensitivity analysis based on risk bias or presence of an outlier. When possible (≥ 3 studies) we tested results for the possibility of a small-study effect using Egger's regression intercept (Egger 1997).

Assessment of reporting biases

We planned to assess publication bias (≥ 3 studies) by constructing funnel plots and using Duval and Tweedie's trim and fill technique (Duval 2000; Duval 2000a).

Data synthesis

We conducted meta-analysis using Review Manager 5.3 (Review Manager 2014) when there were sufficient data from two or more trials. We used fixed- ($I^2 < 25\%$) or random-effects models (Higgins 2003) and presented data as RR, RD, MD or SMD according to review criteria (Measures of treatment effect). When a result was considered positive using a fixed-effect model, we also analysed results using random-effects models to ensure that conclusions were not affected by the type of model used (fixed- versus random-effects).

Where it was not possible to conduct meta-analyses, we presented data narratively.

Subgroup analysis and investigation of heterogeneity

Our a priori criteria for exploring heterogeneity included:

1. type of local anaesthetic drug;
2. concentration of anaesthetic drug;
3. additional block (e.g. with or without sciatic/obturator block);
4. additional injections or infusions at other sites;
5. repeated injections at the same site;
6. use of adjunct oral analgesics; and
7. use of adjunct parenteral analgesics.

Following examination of forest plots for results presenting more than low level heterogeneity ($I^2 \geq 25\%$), we retained the following factors for heterogeneity exploration: participants' age, type of nerve block, type of local anaesthetic used, volume, concentration and dose of local anaesthetic (in lidocaine equivalent) used as loading dose, block administration duration (single injection versus continuous block for the intervention, the comparator or both) and comparator.

Sensitivity analysis

We performed sensitivity analyses based on the risk of bias assessment and presence of outliers.

Summary of findings table and GRADE

We applied the principles of the GRADE system (Guyatt 2008; Guyatt 2011a) to assess the quality of the body of evidence associated with specific outcomes in our review, and constructed 'Summary of findings' tables (Summary of findings for the main comparison; Summary of findings 2) using GRADEpro GDT for:

1. patient-reported pain at rest on arrival in the postoperative care unit;
2. total number of block-related complications (comparison 2 only);
3. acute confusional state;
4. pruritus;
5. hospital length of stay;
6. walking on postoperative day one or first time to walk; and
7. patient satisfaction.

We judged the quality of evidence as high when most information was derived from studies at low risk of bias, and downgraded quality by one level when most information was obtained from studies at high or unclear risk of bias (allocation concealment and blinding of outcome assessors). We downgraded quality by two levels when the proportion of information obtained from studies at high risk of bias was sufficient to affect interpretation of results. In relation to inconsistency, we downgraded the quality of evidence by one level when the I^2 statistic was 50% or higher without satisfactory explanation, and by two levels when the I^2 statistic was 75% or higher without explanation.

We did not downgrade the quality of evidence for indirectness, because all outcomes were based on direct comparisons, were performed on the population of interest and were not surrogate markers (Guyatt 2011b). For imprecision (Guyatt 2011c), we downgraded the quality of evidence by one level when the CI around the effect size was large or overlapped, an absence of effect and failed to exclude an important benefit or harm, or when the number of participants was fewer than the optimal information size. We downgraded evidence quality by two levels when the CI was very wide and included both appreciable benefit and harm. We downgraded the quality of evidence by one level when correcting for the possibility of publication bias (assessed by Duval and Tweedie's fill and trim analysis) changed the conclusion (Duval 2000; Duval 2000a).

Where quality of the body of evidence was assessed as high, further research is very unlikely to change our confidence in the estimate of effect. Where quality was assessed as moderate, further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate. Where quality was low, further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate. Where the quality was very low, any estimate of effect is very uncertain (Guyatt 2008).

RESULTS

Description of studies

Results of the search

We screened 2856 abstracts from CENTRAL ($n = 594$), MEDLINE ($n = 464$), Embase ($n = 1030$), CINAHL ($n = 155$), ISI Web of Science

(n = 189), Scopus (n = 148), clinicaltrials.gov (n = 65), ANZCTR (n = 53), Google Scholar (n = 49) and from the Procedure Specific Postoperative Pain Management ([Prospect](#)) web site (n = 109).

We assessed a total of 2856 records and excluded 2795. We obtained and assessed 89 full-text articles. We excluded a total of 23 trials that studied populations (n = 9) or interventions that were not

relevant to this review (n = 3); were not randomized controlled trial (RCTs) (n = 11); and one was a cross-over trial (see [Characteristics of excluded studies](#)). We identified 11 ongoing trials ([Characteristics of ongoing studies](#)).

A flow diagram of the search is presented ([Figure 1](#)).

Figure 1. Study flow diagram

Included studies

We included 51 studies with 2793 participants in the review (1448 participants randomized to undergo peripheral nerve blocks and 1345 to control groups). Of the 51 studies, we included 45 trials (2491 participants) in the analysis (1288 - peripheral nerve blocks; 1203 - controls). There was not enough information in the reports to allow us to extract data for six trials, even after trying to contact the study authors (Asano 2010; Fouad 2010; Kai 2010; Kendrisic 2013; Marshall 2008; Saksena Shrivastava 2011).

Setting

Trials were performed in Australia (Stevens 2007), Australia and UK (Marshall 2008), Austria and USA (Goytizolo 2016), Belgium (n = 4; Forget 2009; Singelyn 2005; Thomas 2009; Van Herreweghe 2015), Belgium, France and Switzerland (Bichel 1998), Belgium and USA (Shariat 2013), Bosnia and Herzegovina (Lončar 2016), Brazil (Duarte 2009), Bulgaria and France (Bakalov 2016), China (n = 2; Chen 2015; Kai 2010), Denmark (n = 3; Jensen 2012; Thybo 2016; Uhrbrand 1992), Egypt (Anis 2011), Egypt and Japan (Asano 2010), France (n = 2; Biboulet 2004; Souron 2003), Germany (n = 4; Ginz 2000; Kratz 2015; Striebel 1993; Wiesmann 2014), India (Saksena Shrivastava 2011), Ireland (Green 2014), Italy (n = 3; Becchi 2008; Celidonio 2008; Frassanito 2008), Japan (n = 2; Fouad 2010; Nishio 2014), Lithuania (Gelmanas 2010), New Zealand (Fredrickson 2015), Romania (Cucoreanu Badica 2010), Russia (Borisov 2012), Serbia (Kendrisic 2013), Spain (Nohel 2011), Switzerland (n = 2; Fournier 1998; Stevens 2000), Turkey (n = 4; Aksoy 2014; Köroğlu 2008; Türker 2003; Utebey 2009), UK (n = 4; Kearns 2011; Murray 2005; Nicholson 2002; Twyman 1990), UK and USA (Bhatia 2008) USA (n = 2; Marino 2009; Siddiqui 2007).

Funding

Sources of funding were: governmental (n = 2; Kai 2010; Kearns 2011), charity (n = 3; Fredrickson 2015; Goytizolo 2016; Siddiqui 2007), departmental (n = 16; Aksoy 2014; Bhatia 2008; Chen 2015; Cucoreanu Badica 2010; Forget 2009; Ginz 2000; Green 2014; Kratz 2015; Marino 2009; Shariat 2013; Singelyn 2005; Souron 2003; Stevens 2000; Thybo 2016; Twyman 1990; Wiesmann 2014), industry (in part) (Striebel 1993), or unspecified (n = 29; Anis 2011; Asano 2010; Bakalov 2016; Becchi 2008; Biboulet 2004; Bichel 1998; Borisov 2012; Celidonio 2008; Duarte 2009; Fouad 2010; Fournier 1998; Frassanito 2008; Gelmanas 2010; Jensen 2012; Kendrisic 2013; Köroğlu 2008; Lončar 2016; Marshall 2008; Murray 2005; Nicholson 2002; Nishio 2014; Nohel 2011; Saksena Shrivastava 2011; Stevens 2007; Thomas 2009; Türker 2003; Uhrbrand 1992; Utebey 2009; Van Herreweghe 2015).

Trials registered

Eight included trials were registered: Aksoy 2014 (Australian New Zealand Clinical Trials Registry: ACTRN12614000658617); Fredrickson 2015 (Australian and New Zealand Clinical Trials Registry: ACTRN12609000316202); Kearns 2011 (ClinicalTrials.gov: NCT01217294); Kratz 2015 (German Clinical Trial Register (DRKS-ID): DRKS00000752); Marino 2009 (ClinicalTrials.gov: NCT00790179); Shariat 2013 (ClinicalTrials.gov: NCT01758497); Thybo 2016 (EudraCT: 2013-004501-12 and ClinicalTrials.gov: NCT02289937); and Wiesmann 2014 (German Clinical Trial Register DRKS-ID: DRKS00000752).

Date of publication

Trials included in analyses were published between 1990 and 2016.

Characteristics of included participants

Participants in the included trials had mean (or median age) between 32.1 and 76.5 years. Participants' ASA physical status ranged from 1 to 4 or 1.2 to 3.2.

Types of interventions

Trials used peripheral nerve blocks for surgery without additional anaesthetic techniques other than sedation (Aksoy 2014); with the addition of a neuraxial block (n = 13; Becchi 2008; Borisov 2012; Cucoreanu Badica 2010; Gelmanas 2010; Goytizolo 2016; Green 2014; Kai 2010; Kearns 2011; Marino 2009; Marshall 2008; Murray 2005; Stevens 2007; Thybo 2016); or with general anaesthesia (n = 28; Anis 2011; Bhatia 2008; Biboulet 2004; Bichel 1998; Chen 2015; Duarte 2009; Forget 2009; Fouad 2010; Fournier 1998; Frassanito 2008; Fredrickson 2015; Ginz 2000; Kendrisic 2013; Köroğlu 2008; Kratz 2015; Nicholson 2002; Nishio 2014; Shariat 2013; Siddiqui 2007; Singelyn 2005; Souron 2003; Stevens 2000; Striebel 1993; Türker 2003; Twyman 1990; Uhrbrand 1992; Utebey 2009; Wiesmann 2014). The anaesthetic technique used for surgery was unclear for seven trials (Asano 2010; Celidonio 2008; Jensen 2012; Nohel 2011; Saksena Shrivastava 2011; Thomas 2009; Van Herreweghe 2015).

Types of surgery

The types of surgeries performed were reported as: elective hip replacement or arthroplasty (Aksoy 2014; Cucoreanu Badica 2010; Cucoreanu Badica 2010; Frassanito 2008; Gelmanas 2010; Kendrisic 2013; Kratz 2015; Murray 2005; Souron 2003); partial hip replacement (Türker 2003); total hip arthroplasty or replacement (Asano 2010; Becchi 2008; Bhatia 2008; Biboulet 2004; Bichel 1998; Borisov 2012; Celidonio 2008; Chen 2015; Duarte 2009; Forget 2009; Fouad 2010; Fournier 1998; Fredrickson 2015; Ginz 2000; Goytizolo 2016; Green 2014; Jensen 2012; Kai 2010; Kearns 2011; Köroğlu 2008; Marino 2009; Marshall 2008; Nicholson 2002; Nishio 2014; Nohel 2011; Saksena Shrivastava 2011; Shariat 2013; Siddiqui 2007; Singelyn 2005; Stevens 2000; Stevens 2007; Striebel 1993; Thomas 2009; Thybo 2016; Twyman 1990; Uhrbrand 1992; Utebey 2009; Van Herreweghe 2015); or hip surgery (Anis 2011).

Comparators

Peripheral nerve blocks were compared to no block (Anis 2011; Biboulet 2004; Chen 2015; Cucoreanu Badica 2010; Ginz 2000; Goytizolo 2016; Green 2014; Kratz 2015; Marino 2009; Murray 2005; Nicholson 2002; Saksena Shrivastava 2011 (this trial also contained a group who received epidural analgesia, but these data were not retained for analysis), Siddiqui 2007; Stevens 2000; Striebel 1993; Twyman 1990; Uhrbrand 1992; Van Herreweghe 2015; Wiesmann 2014); sham block (Fournier 1998; Jensen 2012; Köroğlu 2008; Shariat 2013; Stevens 2007; Thybo 2016), systemic analgesia (Becchi 2008; Kendrisic 2013; Nishio 2014 (this trial contained a group who received caudal analgesia, but these data were not retained in the analysis), Nohel 2011); systemic analgesia or epidural analgesia (Singelyn 2005; Utebey 2009); epidural analgesia (Asano 2010; Bichel 1998; Borisov 2012; Celidonio 2008; Duarte 2009; Forget 2009; Fouad 2010; Gelmanas 2010; Kai 2010; Marshall 2008; Türker 2003); spinal anaesthesia (Aksoy 2014); spinal

analgesia (Bhatia 2008; Frassanito 2008; Fredrickson 2015; Kearns 2011; Souron 2003); or intravenous lidocaine (Thomas 2009).

Because trials where peripheral nerve blocks were compared to no block, sham block or systemic analgesia all reverted to systemic analgesia as the main modality for postoperative pain treatment (except Goytizolo 2016), these were treated as one comparison. Goytizolo 2016 studied the addition of single injection psoas compartment block compared to epidural analgesia.

Types of peripheral nerve blocks

Peripheral nerve blocks were psoas compartment block (single injection: Anis 2011; Frassanito 2008; Goytizolo 2016; Green 2014; Kai 2010; Souron 2003; Stevens 2000; Twyman 1990; repeated doses: Bhatia 2008; Utebey 2009; continuous block: Asano 2010 (this trial also contained a group who received continuous psoas compartment block plus local anaesthetic infiltration, but data were not retained in the analysis); Becchi 2008; Duarte 2009; Fouad 2010; Fredrickson 2015; Gelmanas 2010; Kendrisic 2013; Marshall 2008; Türker 2003), psoas compartment block plus sciatic nerve block plus iliac crest infiltration (single injection: Aksoy 2014), psoas compartment block or femoral nerve block (single injection: Biboulet 2004; continuous nerve block: Marino 2009), femoral nerve block (or 3-in-1 block) (single injection: Fournier 1998; Köroğlu 2008; Kratz 2015; Nicholson 2002; Wiesmann 2014; repeated doses: Striebel 1993; continuous block: Bichel 1998; Chen 2015; Nishio 2014; Nohel 2011; Saksena Shrivastava 2011; Singelyn 2005; Thomas 2009), femoral nerve block with sciatic nerve block for one group and without sciatic nerve block for another group (continuous block: Celidonio 2008), fascia iliaca block (single injection: Cucereanu Badica 2010; Forget 2009; Kearns 2011; Murray 2005; Shariat 2013; Stevens 2007; Van Herreweghe 2015; continuous block: Borisov 2012), femoral nerve block plus lateral femoral cutaneous nerve block (single injection: Uhrbrand 1992), femoral nerve block plus obturator nerve block plus lateral femoral cutaneous nerve block (single injection: Jensen 2012), obturator nerve block (single injection: Ginz 2000) or lateral femoral cutaneous nerve block (single injection: Thybo 2016). For fascia iliaca blocks, two studies punctured the skin above the inguinal ligament (Stevens 2007; Van Herreweghe 2015).

Block technique

Psoas compartment, femoral or 3-in-1 nerve blocks were performed using a nerve stimulator in 23 studies (Anis 2011; Becchi 2008; Bhatia 2008; Biboulet 2004; Bichel 1998; Duarte 2009; Fournier 1998; Frassanito 2008; Fredrickson 2015; Ginz 2000; Goytizolo 2016; Köroğlu 2008; Kratz 2015; Marino 2009; Nicholson 2002; Siddiqui 2007; Singelyn 2005; Souron 2003; Stevens 2000; Striebel 1993; Türker 2003; Uhrbrand 1992; Wiesmann 2014). Three studies reported using ultrasound guidance alone (Kearns 2011; Shariat 2013; Thybo 2016) and two studies used ultrasound guidance plus nerve stimulator (Aksoy 2014; Nishio 2014). One study used fluoroscopic guidance plus nerve stimulator (Utebey 2009). Landmarks were used in four studies (Borisov 2012; Forget 2009; Stevens 2007; Twyman 1990). One study used injection under direct vision during surgery (Green 2014). Techniques were unspecified in 10 studies (Celidonio 2008; Chen 2015; Cucereanu Badica 2010; Gelmanas 2010; Jensen 2012; Murray 2005; Nohel 2011; Thomas 2009; Van Herreweghe 2015; Türker 2003).

Timing of injection

Local anaesthetics in peripheral nerve blocks were injected before surgical incision in 30 studies (Aksoy 2014; Bhatia 2008; Bichel 1998; Cucereanu Badica 2010; Duarte 2009; Forget 2009; Fouad 2010; Fournier 1998; Frassanito 2008; Fredrickson 2015; Ginz 2000; Goytizolo 2016; Kai 2010; Kearns 2011; Kendrisic 2013; Köroğlu 2008; Kratz 2015; Murray 2005; Nicholson 2002; Siddiqui 2007; Singelyn 2005; Souron 2003; Stevens 2000; Striebel 1993; Thomas 2009; Türker 2003; Twyman 1990; Uhrbrand 1992; Utebey 2009; Wiesmann 2014). Local anaesthetic was injected after surgical incision in nine studies (Anis 2011; Becchi 2008; Biboulet 2004; Borisov 2012; Chen 2015; Green 2014; Marino 2009; Shariat 2013; Thybo 2016). Timing of block performance was unclear in 12 studies (Asano 2010; Bakalov 2016; Celidonio 2008; Gelmanas 2010; Jensen 2012; Lončar 2016; Marshall 2008; Nishio 2014; Nohel 2011; Saksena Shrivastava 2011; Stevens 2007; Van Herreweghe 2015).

Local anaesthetics in peripheral nerve blocks

Local anaesthetics administered as single injection blocks (psoas, femoral or 3-in-1) included bupivacaine (12 studies: Aksoy 2014; Anis 2011; Biboulet 2004; Fournier 1998; Ginz 2000; Goytizolo 2016; Green 2014; Köroğlu 2008; Kratz 2015; Stevens 2000; Twyman 1990; Wiesmann 2014), levobupivacaine (3 studies: Forget 2009; Kearns 2011; Murray 2005), ropivacaine (7 studies: Cucereanu Badica 2010; Frassanito 2008; Jensen 2012; Shariat 2013; Souron 2003; Thybo 2016; Van Herreweghe 2015) or a mixture of lidocaine and bupivacaine (2 studies: Nicholson 2002; Uhrbrand 1992). Volumes varied from 8 mL to 40 mL.

If potency equivalences were assumed as: lidocaine = 1, mepivacaine = 0.8, ropivacaine = 3, levobupivacaine = 3.9 and bupivacaine = 4 (Berde 2009), doses in lidocaine equivalents varied from 75 mg to 800 mg and concentrations from 8 mg/mL to 22.5 mg/mL.

Local anaesthetics used as infusions in continuous blocks included bupivacaine 5 studies (Bichel 1998; Gelmanas 2010; Siddiqui 2007; Singelyn 2005; Türker 2003), lidocaine (Thomas 2009), ropivacaine (6 studies: Becchi 2008; Borisov 2012; Duarte 2009; Fredrickson 2015; Marino 2009; Nishio 2014) or were unspecified (Chen 2015; Nohel 2011). Concentrations in lidocaine equivalents varied from 4.5 to 6 mg/mL. Doses varied from 14 to 66 mg/hour (lidocaine equivalents) and volumes from 3 to 11 mL/hour. Infusions were maintained for 24 hours (Thomas 2009), 36 hours (Siddiqui 2007), 48 hours (7 studies: Becchi 2008; Bichel 1998; Borisov 2012; Celidonio 2008; Duarte 2009; Gelmanas 2010; Singelyn 2005), 72 hours (Chen 2015) or an unspecified duration (Nohel 2011). Local anaesthetics were administered as patient-controlled analgesia in three studies (Chen 2015; Duarte 2009; Fredrickson 2015). Twelve studies reported that local anaesthesia was administered by continuous infusion (Becchi 2008; Bichel 1998; Borisov 2012; Celidonio 2008; Gelmanas 2010; Marino 2009; Nishio 2014; Nohel 2011; Siddiqui 2007; Singelyn 2005; Thomas 2009; Türker 2003).

Local anaesthetics injected for repeated doses included bupivacaine (Striebel 1993; Utebey 2009) and lidocaine (Bhatia 2008). Trials re-injected only one dose varying from 4.9 to 20 mg/mL in lidocaine equivalent concentrations with volumes between 13 mL and 30 mL for doses between 130 mg and 600 mg (in lidocaine equivalents).

Adjuvants in peripheral nerve blocks

For single injection blocks, adjuvant drugs added to local anaesthetics included epinephrine (4 studies: [Aksoy 2014](#); [Fournier 1998](#); [Stevens 2000](#); [Uhrbrand 1992](#)), and clonidine (6 studies: [Anis 2011](#); [Biboulet 2004](#); [Bichel 1998](#); [Celidonio 2008](#); [Kratz 2015](#); [Wiesmann 2014](#)). For one trial ([Anis 2011](#)), clonidine was added for one group while no adjuvant was added for another group. Epinephrine plus clonidine was administered in two studies ([Forget 2009](#); [Stevens 2007](#)). No adjuvants were added to the local anaesthetic blocks in 16 studies ([Anis 2011](#); [Cucereanu Badica 2010](#); [Goytizolo 2016](#); [Green 2014](#); [Jensen 2012](#); [Frassanito 2008](#); [Ginz 2000](#); [Kearns 2011](#); [Köroğlu 2008](#); [Murray 2005](#); [Nicholson 2002](#); [Shariat 2013](#); [Souron 2003](#); [Thybo 2016](#); [Twyman 1990](#); [Van Herreweghe 2015](#)).

For continuous blocks, fentanyl was added in two studies ([Gelmanas 2010](#); [Türker 2003](#)), and no adjuvants were added in 11 studies ([Becchi 2008](#); [Borisov 2012](#); [Chen 2015](#); [Duarte 2009](#); [Fredrickson 2015](#); [Marino 2009](#); [Nishio 2014](#); [Nohel 2011](#); [Siddiqui 2007](#); [Singelyn 2005](#); [Thomas 2009](#)).

There was no adjuvant added in trials where a repeated dose was administered ([Bhatia 2008](#); [Striebel 1993](#); [Utebey 2009](#)).

Narrative summary of included studies

[Aksoy 2014](#) included 80 participants (ASA 3 or 4) undergoing elective hip replacement who were randomized to receive either a combination of psoas compartment block, sciatic nerve block and an iliac crest infiltration, or continuous spinal block. The trial was conducted in Turkey and authors declared no conflicts of interest. We assumed the study was funded by departmental resources.

[Anis 2011](#) included 60 participants (ASA 1 or 2) aged from 18 to 60 years undergoing hip surgery who were randomized to receive either single injection lumbar plexus block with clonidine, single injection lumbar plexus block without clonidine, or no block. The trial was conducted in Cairo, Egypt. The source of funding was unspecified.

[Asano 2010](#) included 45 participants undergoing total hip replacement who were randomized to receive either continuous lumbar plexus block, continuous lumbar plexus block plus local anaesthetic infiltration (this group was not retained for analysis) or intravenous patient-controlled analgesia. The trial was conducted in Japan and in Egypt. The source of funding was unspecified.

[Bakalov 2016](#) included 40 participants undergoing total hip replacement who were randomized to receive either quadratus lumborum block or no block. The trial was conducted in Bulgaria and France. The source of funding was unspecified.

[Becchi 2008](#) included 73 participants (ASA 1 to 3) undergoing total hip arthroplasty who were randomized to receive either continuous psoas compartment block or continuous morphine infusion. The trial was conducted in Italy. The source of funding was unspecified.

[Bhatia 2008](#) included 87 participants (ASA 1 or 2) aged from 18 to 85 years who were randomized to receive either double dose psoas compartment block or intrathecal diamorphine. The trial was conducted in the UK and in USA and funded by departmental resources.

[Biboulet 2004](#) included 45 participants undergoing elective total hip arthroplasty who were randomized to receive either single injection femoral nerve block, single injection psoas compartment block, or no block. The trial was conducted in France. The source of funding was unspecified.

[Bichel 1998](#) included 24 participants undergoing total hip arthroplasty who were randomized to receive either continuous femoral nerve block or epidural analgesia. The trial was conducted in Belgium, France and Switzerland. The source of funding was unspecified.

[Borisov 2012](#) included 60 participants undergoing total hip arthroplasty who were randomized to receive either continuous fascia iliaca block or continuous epidural block. The trial was conducted in Russia. The source of funding was unspecified.

[Celidonio 2008](#) included 46 participants (ASA 1 to 3) undergoing total hip arthroplasty who were randomized to receive either continuous femoral nerve block, continuous femoral nerve block plus single injection sciatic nerve block, or continuous epidural. The trial was conducted in Italy. The source of funding was unspecified.

[Chen 2015](#) included 102 participants scheduled for total hip replacement who were randomized to receive either continuous femoral nerve block plus low molecular weight heparin injections and intermittent pneumatic pressure or no block plus thromboprophylactic measures according to the attending physician's preference. The trial was conducted in China and was funded by departmental resources.

[Cucereanu Badica 2010](#) included 62 participants undergoing unilateral hip arthroplasty who were alternately allocated (quasi-randomized trial) to receive either fascia iliaca block or no block. The trial was conducted in Romania and was funded by departmental resources.

[Duarte 2009](#) included 42 adult participants (ASA 1 to 3) scheduled for hip replacement who were randomized to receive either patient-controlled continuous posterior lumbar plexus block or patient-controlled continuous epidural block. The trial was conducted in Brazil. The source of funding was unspecified.

[Forget 2009](#) included 20 participants aged from 20 to 80 years undergoing primary elective total hip arthroplasty who were randomized to receive either fascia iliaca block or epidural analgesia. The trial was conducted in Belgium and was funded by departmental resources.

[Fouad 2010](#) included 32 participants undergoing elective total hip arthroplasty who were randomized to receive either continuous psoas compartment block or continuous epidural block. The trial was conducted in Japan. The source of funding was unspecified.

[Fournier 1998](#) included 40 participants (ASA 1 to 3) scheduled for total hip arthroplasty who were randomized to receive either 3-in-1 femoral nerve block with local anaesthetics and an adjuvant or sham block. The trial was conducted in Switzerland. The source of funding was unspecified.

[Frassanito 2008](#) included 40 participants (ASA 1 to 3) scheduled for primary unilateral hip arthroplasty who were randomized to receive

either psoas compartment block or intrathecal morphine. The trial was conducted in Italy. The source of funding was unspecified.

[Fredrickson 2015](#) included 50 participants (ASA 1 to 3) undergoing total hip joint replacement who were randomized to receive either patient-controlled continuous psoas compartment block or intrathecal morphine. The trial was conducted in New Zealand and funded by a charity.

[Gelmanas 2010](#) included 34 participants (ASA 1 or 2) undergoing primary hip replacement surgery who were randomized to receive either continuous psoas compartment block or continuous epidural analgesia. The trial was conducted in Lithuania. The source of funding was unspecified.

[Ginz 2000](#) included 40 participants (ASA 1 to 3) undergoing total hip replacement for arthrosis or fracture correction (these participants were excluded from the analysis) who were randomized to receive either obturator nerve block or no block. The trial was conducted in Germany and funded by departmental resources.

[Goytizolo 2016](#) included 92 participants (ASA 1 to 3) aged from 60 to 100 years who were randomized to receive either single injection lumbar plexus block or no block. The trial was conducted in Austria and in the USA and funded by charity.

[Green 2014](#) included 53 participants undergoing primary total hip replacement who were randomized to receive either psoas compartment block or no block. The trial was conducted in Ireland and funded by departmental resources.

[Jensen 2012](#) included 28 participants undergoing total hip arthroplasty who were randomized to receive either a combination of femoral, obturator and lateral cutaneous nerve blocks or placebo blocks. The trial was conducted in Denmark. The source of funding was unspecified.

[Kai 2010](#) included 46 participants (ASA 2 or 3) aged from 67 to 86 years scheduled for total hip replacement who were randomized to receive either psoas compartment block or epidural analgesia. The trial was conducted in China and supported by a grant from the National Natural Science Foundation of China.

[Kearns 2011](#) included 108 participants (ASA 1 to 3) aged between 18 and 85 years who were randomized to receive either fascia iliaca block or intrathecal morphine and a sham block. The trial was conducted in the UK and funded by governmental and charity sources.

[Kendrisic 2013](#) included 62 participants (ASA 2 or 3) undergoing hip replacement surgery who were randomized to receive either continuous psoas compartment block or intravenous patient-controlled analgesia. The trial was conducted in Serbia. The source of funding was unspecified.

[Köroğlu 2008](#) included 30 participants (ASA 1 or 2) undergoing elective total hip arthroplasty who were randomized to receive either 3-in-1 femoral nerve block with local anaesthetic or a sham block. The trial was conducted in Turkey. The source of funding was unspecified.

[Kratz 2015](#) included 80 participants undergoing hip arthroplasty who were randomized to receive either single injection femoral

nerve block or no block. The trial was conducted in Germany and funded using departmental resources.

[Lončar 2016](#) included 30 participants scheduled for elective hip arthroplasty who were randomized to receive single injection femoral nerve block or fascia iliaca block or intravenous morphine. The trial was conducted Bosnia and Herzegovina. The source of funding was unspecified.

[Marino 2009](#) included 225 participants (ASA 1 to 3) aged from 18 to 80 years who were randomized to receive continuous psoas compartment block, continuous femoral nerve block or no block. The trial was conducted in the USA and funded by department resources.

[Marshall 2008](#) included 52 participants scheduled for primary unilateral hip arthroplasty who were randomized to receive either continuous psoas compartment block plus intravenous patient-controlled analgesia or epidural analgesia. The trial was conducted in Australia and in the UK. The source of funding was unspecified.

[Murray 2005](#) included 50 participants (ASA 1 to 3) undergoing primary hip arthroplasty who were randomized to receive either single injection fascia iliaca block or no block. The trial was conducted in the UK. The source of funding was unspecified.

[Nicholson 2002](#) included 36 female participants aged over 55 years who were randomized to receive either single injection 3-in-1 femoral nerve block or no blocks (2 subgroups depending on the agent used for induction of general anaesthesia). The trial was conducted in the UK. The source of funding was unspecified.

[Nishio 2014](#) included 40 participants undergoing primary unilateral hip arthroplasty who were randomized to receive either continuous femoral nerve block or systemic analgesia (2 subgroups: 1 opioid-based, 1 non opioid-based). The trial also included another group who received continuous caudal analgesia (not retained in the analysis). This study was conducted in Japan. The source of funding was unspecified.

[Nohel 2011](#) included 60 participants scheduled for total hip arthroplasty who were randomized to receive either patient-controlled continuous femoral nerve block or intravenous patient-controlled analgesia. The trial was conducted in Spain. The source of funding was unspecified.

[Saksena Shrivastava 2011](#) included 75 participants scheduled for total hip replacement who were randomized to receive either continuous femoral nerve block or no block. The trial was conducted in India. The source of funding was unspecified.

[Shariat 2013](#) included 32 participants (ASA 1 to 3) aged from 18 to 75 years who had undergone hip arthroplasty presenting with pain scores of 3 or more (scale from 0 to 10) despite intravenous patient-controlled analgesia for one hour in the post anaesthesia care unit. The trial was conducted in Belgium and in the USA and funded from departmental resources.

[Siddiqui 2007](#) included 34 participants (ASA 1 to 3) aged from 18 to 80 years undergoing elective unilateral hip arthroplasty who were randomized to receive either continuous psoas compartment block or no block. The trial was conducted in the USA and funded by charity.

[Singelyn 2005](#) included 45 participants (ASA 1 to 3) aged from 18 to 80 years undergoing elective unilateral total hip replacement who were randomized to receive continuous femoral nerve block, intravenous patient-controlled analgesia or epidural analgesia. The trial was conducted in Belgium and funded from departmental resources.

[Souron 2003](#) included 56 participants (ASA 1 or 2) scheduled for primary hip arthroplasty who were randomized to receive either single injection psoas compartment block or intrathecal morphine. The trial was conducted in France and funded from departmental resources.

[Stevens 2000](#) included 60 participants undergoing elective total hip arthroplasty who were randomized to receive either single injection psoas compartment block or no block. The trial was conducted in Switzerland and funded from departmental resources.

[Stevens 2007](#) included 50 participants (ASA 1 to 3) undergoing unilateral total hip replacement who were randomized to receive either single injection fascia iliaca block with local anaesthetics or a sham block. The trial was conducted in Australia. The source of funding was unspecified.

[Striebel 1993](#) included 40 participants undergoing total hip replacement who were randomized to receive either double dose 3-in-1 femoral nerve block or no block. The trial was conducted in Germany and received partial industry support.

[Thomas 2009](#) included 20 participants undergoing total hip arthroplasty who were randomized to receive either continuous femoral nerve block and intravenous saline or intravenous lidocaine and saline infusion on the femoral nerve. The trial was conducted in Belgium. The source of funding was unspecified.

[Thybo 2016](#) included 120 participants undergoing primary total hip arthroplasty who were randomized to receive either single injection lateral femoral cutaneous nerve block with local anaesthetic or saline. The trial was conducted in Denmark. The source of funding was unspecified.

[Türker 2003](#) included 30 participants (ASA 1 to 3) undergoing unilateral partial hip replacement who were randomized to receive either continuous psoas compartment block or continuous epidural analgesia. The trial was conducted in Turkey. The source of funding was unspecified.

[Twyman 1990](#) included 20 women undergoing cemented primary total hip replacement who were randomized to receive either single injection psoas compartment block or no block. The trial was conducted in the UK and funded from departmental resources.

[Uhrbrand 1992](#) included 182 participants undergoing total hip arthroplasty who were randomized to receive either single injection 3-in-1 femoral nerve block plus single injection lateral femoral cutaneous nerve block or no blocks. The trial was conducted in Denmark. The source of funding was unspecified.

[Utebey 2009](#) included 45 participants (ASA 1 or 2) undergoing total hip arthroplasty who were randomized to receive double dose lumbar plexus block, double dose epidural analgesia or no block. The trial was conducted in Turkey. The source of funding was unspecified.

[Van Herreweghe 2015](#) included 78 participants undergoing total hip arthroplasty who were randomized to receive either single injection fascia iliaca block or no block. The trial was conducted in Belgium; The source of funding was unspecified.

[Wiesmann 2014](#) included 80 participants (ASA 1 or 2) aged from 50 to 70 years undergoing elective total hip arthroplasty who were randomized to receive either single injection femoral nerve block or no block. The trial was conducted in Germany and funded from departmental resources.

Excluded studies

We excluded 23 trials. Eight trials ([Adali 2011](#); [Bang 2016](#); [Bogoch 2002](#); [Eyi 2014](#); [Ghabach 2016](#); [Nooh 2016](#); [Segado Jiménez 2010](#); [Sun 2014](#)) investigated populations that were not relevant to this review. Three trials studied interventions that did not match review inclusion criteria ([Berge 2004](#); [Dahn 1999](#); [Dahn 2003](#)). Eleven studies were not randomized ([Akhtar 2014](#); [Dahl 2012](#); [de Leeuw 2011](#); [Finn 2016](#); [Goitia Arrola 2009](#); [Pandin 1998](#); [Pavy 2007](#); [Perrier 2010](#); [Rowley 2013](#); [Tanzer 2012](#); [Vilchis 2012](#)) and one was a cross-over trial ([Thybo 2016a](#)). (See [Characteristics of excluded studies](#)).

Awaiting classification

We found three trials (first identified as ongoing from trial registers), that have been published after the date of the last search (December 2016) ([NCT02242201](#); [NCT02344264](#); [NCT02568995](#)) ([Characteristics of studies awaiting classification](#)). These trials will be formally evaluated for possible inclusion at the next update.

Ongoing studies

We identified 11 other trials from searching trials registers ([NCT01378949](#); [NCT01782612](#); [NCT01875289](#); [NCT01911949](#); [NCT02056145](#); [NCT02108847](#); [NCT02299271](#); [NCT02544269](#); [NCT02658149](#); [NCT02658240](#); [NCT02720471](#); [Characteristics of ongoing studies](#)).

Four trials appear to be unlikely to complete for the following reasons: recruitment status unknown, completion date passed and status not verified in more than two years ([NCT01378949](#); [NCT01782612](#); [NCT02056145](#)), or suspended for lack of funding and difficulty to recruit: [NCT01378949](#). These trials have nevertheless been left as ongoing trials to enable verification of their status at the next update.

Two trials are listed as terminated but both mentioned that they recruited some participants ([NCT02299271](#); [NCT02544269](#)). Emails have been sent to the study authors to try to obtain preliminary results for possible inclusion at the next update.

Three studies have been completed but we could not find the reports ([NCT01875289](#); [NCT02108847](#); [NCT02720471](#)). We wrote emails to the study authors to obtain more information for possible inclusion at the next update.

Two trials are still recruiting participants ([NCT02658149](#); [NCT02658240](#)) (Status checked October 2017).

Risk of bias in included studies

All studies had some degree of risk of bias [Figure 2](#); [Figure 3](#). Random sequence generation, allocation concealment and

blinding of outcome assessors were the domains where risks of bias were the most frequent.

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies

Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Aksoy 2014	+	+	-	+	+	+	?
Anis 2011	+	+	?	?	+	+	+
Asano 2010	?	?	?	?	?	?	+
Bakalov 2016	?	?	?	?	+	?	?
Becchi 2008	+	?	-	+	+	+	?
Bhatia 2008	+	?	?	+	+	+	+
Biboulet 2004	?	?	?	+	+	+	?
Bichel 1998	?	?	-	?	+	+	+
Borisov 2012	+	+	-	?	+	+	?
Celidonio 2008	+	?	+	+	+	+	+
Chen 2015	+	?	-	?	+	+	-
Cucereanu Badica 2010	-	-	+	+	+	+	+
Duarte 2009	+	+	?	+	+	-	?
Forget 2009	+	?	?	+	+	+	+
Fouad 2010	?	?	?	?	+	?	+
Fournier 1998	?	?	+	+	+	+	+
Frassanito 2008	?	?	?	+	+	+	+
Fredrickson 2015	+	+	-	-	+	+	+
Gelmanas 2010	?	?	+	+	+	?	+
Ginz 2000	+	?	-	-	+	+	?

Figure 3. (Continued)

Ginz 2000	+	?	-	-	+	+	?
Goytizolo 2016	+	+	?	+	+	+	+
Green 2014	+	?	?	+	+	+	+
Jensen 2012	?	?	+	+	?	?	?
Kai 2010	?	?	?	?	+	+	?
Kearns 2011	+	+	?	+	+	+	+
Kendrisic 2013	?	?	-	?	+	?	?
Köroğlu 2008	+	?	+	+	+	+	+
Kratz 2015	+	+	-	+	-	+	?
Lončar 2016	?	?	?	?	+	+	?
Marino 2009	+	?	-	?	+	+	+
Marshall 2008	+	?	-	?	+	?	-
Murray 2005	?	?	-	?	+	+	?
Nicholson 2002	+	?	?	?	+	+	+
Nishio 2014	+	+	-	?	+	+	+
Nohel 2011	?	?	-	?	?	?	?
Saksena Shrivastava 2011	?	?	-	?	?	?	?
Shariat 2013	+	+	+	+	+	+	?
Siddiqui 2007	+	+	-	-	+	+	+
Singelyn 2005	+	?	-	?	+	+	+
Souron 2003	+	+	?	+	+	+	+
Stevens 2000	?	?	+	+	+	+	+
Stevens 2007	+	?	+	+	?	+	+
Striabel 1993	+	?	-	?	+	+	+
Thomas 2009	?	?	+	+	+	+	+
Thybo 2016	+	+	+	+	?	?	?
Türker 2003	?	?	?	+	+	+	+
Twyman 1990	?	?	?	?	+	+	+
Uhrbrand 1992	?	?	?	+	+	+	+
Utebey 2009	?	?	-	?	+	+	+
Van Herreweghe 2015	?	?	+	+	+	?	+

Figure 3. (Continued)

Van Herreweghe 2015	?	?	+	+	+	?	+
Wiesmann 2014	+	+	-	?	+	+	+

Allocation

Allocation concealment was rated as at low risk of bias for more than 25% (14/51) of the included studies (Aksoy 2014; Anis 2011; Borisov 2012; Duarte 2009; Fredrickson 2015; Goytizolo 2016; Kearns 2011; Kratz 2015; Nishio 2014; Shariat 2013; Siddiqui 2007; Souron 2003; Thybo 2016; Wiesmann 2014). For 38 studies (Asano 2010; Bakalov 2016; Becchi 2008; Bhatia 2008; Biboulet 2004; Bichel 1998; Celidonio 2008; Chen 2015; Forget 2009; Fouad 2010; Fournier 1998; Frassanito 2008; Gelmanas 2010; Ginz 2000; Green 2014; Jensen 2012; Kai 2010; Kendrisic 2013; Köroğlu 2008; Lončar 2016; Marino 2009; Marshall 2008; Murray 2005; Nicholson 2002; Nohel 2011; Saksena Shrivastava 2011; Singelyn 2005; Stevens 2000; Stevens 2007; Striebel 1993; Thomas 2009; Türker 2003; Twyman 1990; Uhrbrand 1992; Utebey 2009; Van Herreweghe 2015), there was not enough information in the report and allocation concealment was rated as unclear. Cucereanu Badica 2010 was rated as at high risk because studies authors used alternate allocation, therefore allocation of the next participant could be anticipated by the researcher recruiting participants.

Blinding

Blinding of participants and personnel taking care of participants were rated as at low risk of bias for 25% (13/51) of included studies (Celidonio 2008; Cucereanu Badica 2010; Fournier 1998; Gelmanas 2010; Jensen 2012; Köroğlu 2008; Shariat 2013; Stevens 2000; Stevens 2007; Thomas 2009; Thybo 2016; Van Herreweghe 2015). For 19 studies (Anis 2011; Asano 2010; Bakalov 2016; Bhatia 2008; Biboulet 2004; Duarte 2009; Forget 2009; Fouad 2010; Frassanito 2008; Goytizolo 2016; Green 2014; Kai 2010; Kearns 2011; Lončar 2016; Nicholson 2002; Souron 2003; Türker 2003; Twyman 1990; Uhrbrand 1992), there was not enough information in the report and blinding of participants and personnel taking care of participants was rated as unclear. Blinding of participants or personnel taking care of participants had to be rated as at high risk of bias for 20 studies (Aksoy 2014; Becchi 2008; Bichel 1998; Borisov 2012; Chen 2015; Fredrickson 2015; Ginz 2000; Kendrisic 2013; Kratz 2015; Marino 2009; Marshall 2008; Murray 2005; Nishio 2014; Nohel 2011; Saksena Shrivastava 2011; Siddiqui 2007; Singelyn 2005; Striebel 1993; Utebey 2009; Wiesmann 2014).

Blinding of outcome assessors was rated as at low risk of bias for more than 50% (26/51) of the included studies (Aksoy 2014; Becchi 2008; Bhatia 2008; Biboulet 2004; Celidonio 2008; Cucereanu Badica 2010; Duarte 2009; Forget 2009; Fournier 1998; Frassanito 2008; Gelmanas 2010; Goytizolo 2016; Green 2014; Jensen 2012; Kearns 2011; Köroğlu 2008; Kratz 2015; Shariat 2013; Souron 2003; Stevens 2000; Stevens 2007; Thomas 2009; Thybo 2016; Türker 2003; Uhrbrand 1992; Van Herreweghe 2015). For 22 studies (Anis 2011; Asano 2010; Bakalov 2016; Bichel 1998; Borisov 2012; Chen 2015; Fouad 2010; Kai 2010; Kendrisic 2013; Lončar 2016; Marino 2009; Marshall 2008; Murray 2005; Nicholson 2002; Nishio 2014; Nohel 2011; Saksena Shrivastava 2011; Singelyn 2005; Striebel 1993; Twyman 1990; Utebey 2009; Wiesmann 2014), there was not enough information to rate blinding of outcome assessors. Blinding

of outcome assessor was rated as at high risk for three studies (Fredrickson 2015; Ginz 2000; Siddiqui 2007).

Incomplete outcome data

This domain was judged as at low risk of bias for more than 75% (44/51) of the included studies (Aksoy 2014; Anis 2011; Bakalov 2016; Becchi 2008; Bhatia 2008; Biboulet 2004; Bichel 1998; Borisov 2012; Celidonio 2008; Chen 2015; Cucereanu Badica 2010; Duarte 2009; Forget 2009; Fouad 2010; Fournier 1998; Frassanito 2008; Fredrickson 2015; Gelmanas 2010; Ginz 2000; Goytizolo 2016; Green 2014; Kai 2010; Kearns 2011; Kendrisic 2013; Köroğlu 2008; Lončar 2016; Marino 2009; Marshall 2008; Murray 2005; Nicholson 2002; Nishio 2014; Shariat 2013; Siddiqui 2007; Singelyn 2005; Souron 2003; Stevens 2000; Striebel 1993; Thomas 2009; Türker 2003; Twyman 1990; Uhrbrand 1992; Utebey 2009; Van Herreweghe 2015; Wiesmann 2014). Incomplete outcome data was rated as unclear for six studies (Asano 2010 (conference abstract and no data suitable for analysis); Jensen 2012 (conference abstract, preliminary report on 28 participants out of 81 scheduled); Nohel 2011 (60 participants enrolled, exact number of participants for whom results are reported not mentioned); Saksena Shrivastava 2011 (conference abstract, no data suitable for analysis, 75 participants enrolled but number for whom results are reported not mentioned); Stevens 2007 (50 participants enrolled, 6 participants excluded from analysis because of study exclusion criteria or breaches in the study protocol or inadequate data collection); Thybo 2016 (20 participants out of the 120 enrolled did not complete the study because inadequate selection or protocol breach or failed spinal anaesthesia)). One trial (Kratz 2015) was rated as at high risk for this domain because 28 of the 80 participants enrolled (> 20%) were excluded from analysis due to violation protocol.

Selective reporting

This domain was judged as at low risk of bias for more than 75% (39/51) of the included studies (Aksoy 2014; Anis 2011; Becchi 2008; Bhatia 2008; Biboulet 2004; Bichel 1998; Borisov 2012; Celidonio 2008; Chen 2015; Cucereanu Badica 2010; Forget 2009; Fournier 1998; Frassanito 2008; Fredrickson 2015; Ginz 2000; Goytizolo 2016; Green 2014; Kai 2010; Kearns 2011; Köroğlu 2008; Kratz 2015; Lončar 2016; Marino 2009; Murray 2005; Nicholson 2002; Nishio 2014; Shariat 2013; Siddiqui 2007; Singelyn 2005; Souron 2003; Stevens 2000; Stevens 2007; Striebel 1993; Thomas 2009; Türker 2003; Twyman 1990; Uhrbrand 1992; Utebey 2009; Wiesmann 2014). For eleven studies (Asano 2010 (conference abstract with no results reported); Bakalov 2016 (conference abstract in which measurements made are not reported in the method section); Fouad 2010 (conference abstract, no number given); Gelmanas 2010 (conference abstract, limited information); Jensen 2012 (preliminary results for 28 participants out of 81 scheduled); Kendrisic 2013 (conference abstract, limited information); Marshall 2008 (conference abstract, limited information); Nohel 2011 (conference abstract, limited information, variance (error bars) not reported); Saksena Shrivastava 2011 (conference abstract, limited information); Thybo 2016 (few data for pain scores at 8 and 12

hours due to "unforeseen difficulties" during data collection) and [Van Herreweghe 2015](#) (conference abstract, limited information)), there was not enough information to rate this domain. [Duarte 2009](#) was rated as at high risk for selective reporting because study authors mention in their method section that they collected and analysed data of adverse effects (nausea, vomiting, pruritus, urinary retention, and motor blockade of the lower limbs) but these results were not provided.

Other potential sources of bias

This domain was judged as at low risk of bias for more than 50% (32/51) of the included studies ([Anis 2011](#); [Asano 2010](#); [Bhatia 2008](#); [Bichel 1998](#); [Celidonio 2008](#); [Cucereanu Badica 2010](#); [Forget 2009](#); [Fouad 2010](#); [Fournier 1998](#); [Frassanito 2008](#); [Fredrickson 2015](#); [Gelmanas 2010](#); [Goytizolo 2016](#); [Green 2014](#); [Kearns 2011](#); [Köroğlu 2008](#); [Marino 2009](#); [Nicholson 2002](#); [Nishio 2014](#); [Siddiqui 2007](#); [Singelyn 2005](#); [Souron 2003](#); [Stevens 2000](#); [Stevens 2007](#); [Striebel 1993](#); [Thomas 2009](#); [Türker 2003](#); [Twyman 1990](#); [Uhrbrand 1992](#); [Utebey 2009](#); [Van Herreweghe 2015](#); [Wiesmann 2014](#)). For seventeen studies there was not enough information in the reports to judge this domain or data were not in intention-to-treat analysis and/or groups characteristics before intervention may have differed enough to possibly have an influence on the results ([Aksoy 2014](#) (participants with failed or insufficient blockade were excluded from the analysis); [Bakalov 2016](#) (conference abstract, limited information); [Becchi 2008](#) (not in intention-to-treat); [Biboulet 2004](#) (not in intention-to-treat); [Borisov 2012](#) (not in intention-to-treat); [Duarte 2009](#) (not in intention-to-treat); [Ginz 2000](#) (not in intention-to-treat); [Jensen 2012](#) (conference abstract, limited information); [Kai 2010](#) (conference abstract, limited information); [Kendrisic 2013](#) (conference abstract, limited information); [Kratz 2015](#) (not in intention-to-treat, preoperative pain scores were higher (although not statistically significantly so) in the femoral nerve block group (4.2 ± 2.9 versus 2.9 ± 3.1); [Lončar 2016](#) (conference abstract, limited information); [Murray 2005](#) (conference abstract, limited information); [Nohel 2011](#) (conference abstract, limited information); [Saksena Shrivastava 2011](#) (conference abstract, limited information); [Shariat 2013](#) (mean pain scores before intervention were 1 point higher in the fascia iliaca group, the difference was not statistically significant); [Thybo 2016](#) (not in intention-to-treat)). [Chen 2015](#) (thrombosis prophylaxis differed between groups) and [Marshall 2008](#) (IV patient-controlled analgesia provided to one group only) were judged as at risk of other bias.

Effects of interventions

See: [Summary of findings for the main comparison](#) Peripheral nerve blocks compared to systemic analgesia for elective primary total hip replacement; [Summary of findings 2](#) Peripheral nerve block compared to neuraxial block for elective primary total hip replacement

1.Comparison 1: Peripheral nerve block versus no block, sham block or systemic analgesia for postoperative analgesia

Primary outcomes

1.1 Participant-reported pain at rest and with movement on visual analogue scale (VAS), numeric rating scale (NRS), or other similar scales or on ordinal or qualitative scales (FACES)

1.1.1 Pain at rest and with movement on arrival in the postoperative care unit

Nine trials (429 participants) evaluated the effect of peripheral nerve blocks on pain at rest on arrival in the postoperative care unit: psoas compartment block ([Biboulet 2004](#); [Goytizolo 2016](#); [Utebey 2009](#)) or femoral nerve block ([Köroğlu 2008](#); [Kratz 2015](#); [Nishio 2014](#) (2 subgroups depending on comparison versus opioids or non-opioids); [Stevens 2000](#); [Striebel 1993](#); [Wiesmann 2014](#)). Random sequence generation was rated as at low risk of bias for [Goytizolo 2016](#); [Köroğlu 2008](#); [Kratz 2015](#); [Nishio 2014](#); [Striebel 1993](#) and [Wiesmann 2014](#); and this domain was judged as unclear for [Biboulet 2004](#); [Stevens 2000](#) and [Utebey 2009](#). Allocation concealment was rated as at low risk of bias for [Goytizolo 2016](#); [Kratz 2015](#); [Nishio 2014](#) and [Wiesmann 2014](#); and as unclear for [Biboulet 2004](#); [Köroğlu 2008](#); [Stevens 2000](#); [Striebel 1993](#) and [Utebey 2009](#). Blinding of participants or personnel taking care of the participants was rated as at low risk of bias for [Köroğlu 2008](#) and [Stevens 2000](#); as unclear for [Biboulet 2004](#) and [Goytizolo 2016](#); and as at high risk for [Kratz 2015](#); [Nishio 2014](#); [Striebel 1993](#); [Utebey 2009](#) and [Wiesmann 2014](#). Blinding of outcome assessor was rated as at low risk of bias for [Biboulet 2004](#); [Goytizolo 2016](#); [Kratz 2015](#); [Köroğlu 2008](#) and [Stevens 2000](#); as unclear for [Nishio 2014](#); [Striebel 1993](#); [Utebey 2009](#) and [Wiesmann 2014](#); and at high risk for [Kratz 2015](#). Incomplete outcome data (attrition bias) was rated as at low risk of bias for all trials included in this analysis. Other risks were judged as at low risk of bias for [Goytizolo 2016](#); [Köroğlu 2008](#); [Nishio 2014](#); [Stevens 2000](#); [Striebel 1993](#); [Utebey 2009](#) and [Wiesmann 2014](#). [Biboulet 2004](#) and [Kratz 2015](#) were judged as unclear because data were not analysed according to the intention-to-treat principle. Furthermore, for [Kratz 2015](#), although this was not statistically significant, pain scores measured before the intervention were higher for participants included in the femoral nerve block group (4.2 ± 2.9 versus 2.9 ± 3.1).

Peripheral nerve blocks decreased pain at rest on arrival in the postoperative care unit (SMD -1.12, 95% CI -1.67 to -0.56; I^2 84%). Egger's regression intercept showed no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill technique indicated imbalance of two studies missing to left of mean for an adjusted point estimate (SMD -1.44, 95% CI -2.09 to -0.80; random-effects model). The effect was similar for psoas compartment versus femoral nerve block (I^2 0%; [Analysis 1.1](#)). Volume of solution injected as a loading dose was unknown for [Nishio 2014](#). Excluding this study, the effect was proportional to the volume of local anaesthetic injected ([Figure 4](#); $P < 0.00001$) and to the dose in lidocaine equivalents ([Figure 5](#); $P = 0.0001$). Taking a study at low risk of bias for which the standard deviation (SD) is known and with a typical SD in the control group ([Wiesmann 2014](#); SD = 2.2), the difference would be equivalent to 3.2 on a scale from 0 to 10. For a large trial and using the same SD, 68 participants would be required to decrease VAS scores from 5 to 3.5 ([Inference for means calculator](#)) (alpha 0.05; beta 0.2; 2-sided test).

Figure 4. Comparison peripheral nerve block versus no block or sham block or systemic analgesia Meta-regression analysis of effect of peripheral nerve block on pain on arrival in postoperative care unit versus volume of the local anaesthetic injected as the loading dose. The effect size was proportional to the concentration used ($P < 0.00001$). The largest effect size (standardized mean difference (SMD) -4.56, 95% CI -5.91 to -3.20) was obtained by [Köroğlu 2008](#) where a 3-in-1 block with 40 mL 0.25% bupivacaine was compared to a sham block and postoperative analgesia was completed with IV patient-controlled analgesia with tramadol plus IV meperidine on request.

Figure 5. Comparison peripheral nerve blocks versus no block or sham block or systemic analgesia. Meta-regression of pain on arrival in postoperative care unit versus local anaesthetic dose in lidocaine equivalent injected as loading dose. The effect size was proportional to the dose injected ($P = 0.0001$). The largest effect size (SMD -4.56, 95% CI -5.91 to -3.20) was obtained by [Köroğlu 2008](#) where a 3-in-1 block with 40 mL 0.25% bupivacaine was compared to a sham block and postoperative analgesia was completed with IV patient-controlled analgesia with tramadol plus IV meperidine on request.

For pain at rest on arrival in the postoperative care unit, we downgraded evidence quality by one level for risk of bias because 50% or more of the included trials were judged at unclear or high risk of bias for allocation concealment, blinding of the outcome assessor or both. We did not downgrade evidence quality for inconsistency because reasonable explanation was found to explain heterogeneity. We did not downgrade for indirectness because all trials were direct comparisons performed with the population of interest and this was not a surrogate marker. We did not downgrade for imprecision because the optimal information size was achieved. We did not downgrade for publication bias because applying a correction would not change the conclusion. We rated the quality of the body of evidence as moderate.

Köroğlu 2008 provided data for pain with movement at arrival in the postoperative care unit (SMD -3.62, 95% CI -4.78 to -2.46).

1.1.2 Pain at rest and with movement from 0.5 to 2 hours after surgery

Nine trials (438 participants) evaluated pain at rest from 0.5 to 2 hours after surgery: femoral nerve block (Kratz 2015; Lončar 2016; Striebel 1993; Wiesmann 2014), fascia iliaca block (Lončar 2016; Shariat 2013) or psoas compartment block (Anis 2011; Green 2014; Siddiqui 2007; Stevens 2000) (SMD -0.67, 95% CI -1.06 to -0.29; I^2 71%; Analysis 1.2). In Shariat 2013, participants were recruited only if pain scores remained at ≥ 3 (scale from 0 to 10) despite intravenous patient-controlled analgesia with morphine for one hour in the postoperative care unit. Egger's regression intercept showed that a small-study effect could participate to the high I^2 statistic value ($P < 0.05$; 2-tailed). Analysis using Duval and Tweedie's trim and fill method indicated imbalance of two studies missing to right of mean for an adjusted point estimate (SMD -0.50, 95% CI -0.91 to -0.09; random-effects model). Psoas compartment block decreased pain at rest from 0.5 to 2 hours after surgery (SMD -0.91, 95% CI -1.20 to -0.62; I^2 0%) but we did not find a difference for a femoral nerve block: (SMD -0.28, 95% CI -0.85 to 0.28; I^2 68%) or fascia iliaca block (SMD -1.21, 95% CI -3.34 to 0.92); heterogeneity (I^2) between subgroups 49% (P value = 0.14). When Siddiqui 2007 was considered (control group SD = 1.81), the difference in pain score for psoas compartment blocks was equivalent to 1.7 (on a scale from 0 to 10) and 46 participants would be required in a large trial to achieve decrease from 5 to 3.5 in VAS scores (alpha 0.05; beta 0.2; 2-sided test).

We found no data for pain with movement from 0.5 to 2 hours after surgery or block placement for trials where the block was performed for postoperative analgesia.

1.1.3 Pain at rest and with movement from 4 to 6 hours after surgery

We included 13 trials (599 participants) that evaluated pain at rest between 4 and 6 hours after surgery (SMD -0.62, 95% CI -0.92 to -0.32; I^2 66%; Analysis 1.3). Egger's regression intercept showed no evidence of small-study effect (2-sided test). Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to right of mean for an adjusted point estimate (SMD -0.56, 95% CI -0.86 to -0.27; random-effects model).

Femoral nerve block was used in five studies (223 participants) (Kratz 2015; Nishio 2014; Singelyn 2005; Striebel 1993; Wiesmann 2014) (SMD -0.30, 95% CI -0.98 to 0.38; I^2 81%). Two studies (Kratz 2015; Wiesmann 2014) added clonidine to the loading dose of local anaesthetic. Singelyn 2005 added epinephrine, Striebel 1993 added

no adjuvant, and the information was not reported by Nishio 2014. Fascia iliaca with a puncture site above (Stevens 2007), or below the inguinal ligament (Cucoreanu Badica 2010) was used for two trials (SMD -0.36, 95% CI -1.06 to 0.33; I^2 54%).

Psoas compartment block was used in six trials (303 participants) (SMD -0.88, 95% CI -1.12 to -0.64; I^2 0%); I^2 for heterogeneity between subgroups was 50%. The difference for psoas compartment block was equivalent to 1.4 (on a scale from 0 to 10) (Siddiqui 2007: control group SD = 2.2). Further analysis from data provided by Siddiqui 2007 indicated that 68 participants would be required in a simple trial to decrease VAS scores from 5 to 3.5 (alpha 0.05; beta 0.2; 2-sided test).

Three trials (Becchi 2008; Cucoreanu Badica 2010; Singelyn 2005, 120 participants) evaluated pain scores with movement from 4 to 6 hours (SMD -0.46, 95% CI -1.12 to 0.20; I^2 64%; Analysis 1.4). Egger's regression intercept showed no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method showed no evidence of publication bias. Femoral nerve block (Singelyn 2005) (SMD 0.00, 95% CI -0.86 to 0.86), fascia iliaca block with the puncture site below the inguinal ligament (Cucoreanu Badica 2010) (SMD -0.18, 95% CI -0.91 to 0.55) or psoas compartment block (Becchi 2008) (SMD -1.00, 95% CI -1.51 to -0.49) were used (I^2 for heterogeneity between subgroups 64%).

1.1.4 Pain at rest and with movement at 24 hours after surgery

Six trials (Becchi 2008; Kratz 2015; Siddiqui 2007; Singelyn 2005; Stevens 2007; Wiesmann 2014, 303 participants) evaluated pain scores at rest after single injection block with clonidine (Kratz 2015; Stevens 2007; Wiesmann 2014) or continuous peripheral nerve block (Becchi 2008; Siddiqui 2007; Singelyn 2005) (SMD -0.66, 95% CI -1.05 to -0.28; I^2 61%; Analysis 1.5). Egger's regression intercept showed no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method showed no evidence of publication bias. Femoral nerve block (Kratz 2015; Singelyn 2005; Wiesmann 2014) (SMD -0.68, 95% CI -1.27 to -0.10; I^2 63%), fascia iliaca block (SMD 0.00, 95% CI -0.59 to 0.59) or psoas compartment block (SMD -0.97, 95% CI -1.37 to -0.56; I^2 0%) were used; I^2 for heterogeneity between subgroups 72%. Considering a trial with low risk of bias and typical SD (Shariat 2013; control group SD = 2.2), the difference would be equivalent to 1.5 on a scale from 0 to 10.

Three trials with 317 participants (Becchi 2008; Marino 2009 (2 subgroups); Singelyn 2005), evaluated pain scores with movement after continuous peripheral nerve block (there were no data for single injection block for this outcome) at 24 hours after surgery (SMD -0.71, 95% CI -1.26 to -0.17; I^2 78%; Analysis 1.6). Egger's regression intercept showed no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method showed no evidence of publication bias (random-effects model). The effect was seen with psoas compartment block (SMD -1.13, 95% CI -1.46 to -0.80; I^2 0%) but we did not find a difference with femoral nerve block (SMD -0.24, 95% CI -0.59 to 0.12; I^2 0%; I^2 for heterogeneity for subgroups 92%). Taking a trial at low risk of bias and with a typical SD (Marino 2009; control group SD = 2.3), the difference would be equivalent to 1.6 on a scale from 0 to 10.

1.1.5 Pain at rest and with movement at 48 hours after surgery

Data were available for two trials (Becchi 2008; Singelyn 2005; 93 participants) that evaluated pain at rest at 48 hours after surgery

for participants who benefited from continuous peripheral nerve block (SMD -0.80, 95% CI -1.35 to -0.25; I^2 29%). Singelyn 2005 used continuous femoral nerve block and Becchi 2008 used continuous psoas compartment block (I^2 for heterogeneity between subgroups 29%; Analysis 1.7). Taking a trial at low risk of bias and with a typical SD (Duarte 2009; control group SD = 1.80), the difference would be equivalent to 1.44 on a scale from 0 to 10.

Three trials (Becchi 2008; Marino 2009; Singelyn 2005; 317 participants) evaluated pain with movement at 48 hours after surgery in participants with continuous peripheral nerve block (SMD -0.62, 95% CI -1.13 to -0.11; I^2 75%; Analysis 1.8). Egger's regression intercept showed no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method showed no evidence of publication bias (random-effects model). Continuous compartment block reduced pain scores with movement at 48 hours after surgery (SMD -0.93, 95% CI -1.25 to -0.61; I^2 0%). We did not find a difference with continuous femoral nerve block (SMD -0.16, 95% CI -0.60 to 0.28; I^2 17%; I^2 for heterogeneity between subgroups 87%). Taking a trial at low risk of bias and with a typical SD (Singelyn 2005; SD of the control group 1.80), the difference would be equivalent to 1.12 on a scale from 0 to 10.

1.2 Total number of nerve block-related complications (e.g. erythema, damage to surrounding structures, allergic reactions, infections, transient and lasting neurological damage)

One local haematoma in the groin was reported after accidental puncture of the femoral artery during performance of 3-in-1 femoral nerve block under nerve stimulator guidance (Uhrbrand 1992). One persistent (at 3 months) delayed paresis was reported by Siddiqui 2007 following psoas compartment catheter insertion under nerve stimulator guidance. An 82 year old female participant developed a delayed quadriceps weakness that was not present when the catheter was removed at 36 hours but was discovered by the surgeon at her postoperative visit four weeks later. Magnetic resonance imaging revealed no abnormality and the participant declined further investigation. Weakness improved but was present at the three month follow-up visit. Compression from an haematoma was suspected: international normalized ratio of 5.6 was measured on postoperative day 3 while the participant was receiving warfarin. Warfarin was started at 5 mg the evening before surgery and continued at 5 mg per day each night thereafter (Table 1).

Siddiqui 2007 was judged as at low risk of bias for random sequence generation, allocation concealment, incomplete outcome data (attrition bias), selective reporting (reporting bias) and other bias; and as at high risk of bias for blinding of participant or personnel taking care of the participant and blinding of outcome assessment. Uhrbrand 1992 was judged as at unclear risk of bias for random sequence generation, allocation concealment and blinding of participant or personnel taking care of the participant and as at low risk of bias for all other domains.

Secondary outcomes

1.1 Analgesic requirements

We included 12 trials (897 participants) that reported analgesia requirements delivered as single injection blocks (10 studies: Anis 2011; Cucereanu Badica 2010; Fournier 1998; Ginz 2000; Murray 2005; Shariat 2013; Stevens 2007; Thybo 2016; Uhrbrand 1992; Van Herreweghe 2015); repeated doses (Utebey 2009) or continuous

nerve block (Marino 2009) and evaluated opioid consumption from 0 to 24 hours (SMD -0.62, 95% CI -0.89 to -0.35; I^2 86%; Analysis 1.9). Egger's regression intercept showed no evidence of small-study effect ($P = 0.03$; 2-sided test). Analysis using Duval and Tweedie's trim and fill method indicated imbalance of two studies missing to right of mean for an adjusted point estimate (SMD -0.52, 95% CI -0.79 to -0.24). When trials were subgrouped by type of block, peripheral nerve block was found to reduce opioid consumption when femoral nerve block with or without femoral lateral cutaneous nerve block (SMD -0.39, 95% CI -0.61 to -0.17); fascia iliaca block (SMD -0.84, 95% CI -1.27 to -0.41); or psoas compartment block (SMD -0.96, 95% CI -1.27 to -0.65; I^2 for heterogeneity between subgroups 86%) was used.

1.2 Minimal clinically important improvement in pain

Data were not available for proportions of participants with pain VAS scale differences of 2 cm on a 0 cm to 10 cm scale as a categorical variable. A mean difference of 2 cm or more between the intervention and control groups was found for pain at rest and with movement on arrival in the postoperative care unit.

1.3 Complications specific to method of treatment

Table 1.

1.3.1 Complications from peripheral nerve blocks (damage to surrounding structures at site of nerve block)

Becchi 2008 reported one instance of catheter dislodgment. Marino 2009 reported that catheters were not functional ($N = 2$) or were occluded ($N = 2$). Epidural extension of psoas compartment block was reported by Biboulet 2004 ($N = 4$), Marino 2009 ($N = 5$), Stevens 2000 ($N = 3$) and Utebey 2009 ($N = 2$). Uhrbrand 1992 reported one local haematoma. One persistent (at 3 months) delayed paresis was reported in Siddiqui 2007 (see details above).

1.3.2 Complications from systemic analgesia or general anaesthesia (other complications as detailed in each study)

Siddiqui 2007 reported that one participant developed respiratory depression from systemic analgesia.

1.4 General medical complications within six weeks after surgery

1.4.a Gastrointestinal: nausea and vomiting, constipation, ileus

We included five trials (282 participants) that reported results for nausea (Goytizolo 2016; Jensen 2012), nausea and vomiting (Stevens 2007; Wiesmann 2014) or vomiting (Bakalov 2016) for the first 24 hours (RR 0.86, 95% CI 0.53 to 1.41; I^2 17%; Analysis 1.10). Egger's regression intercept showed no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to right of mean for an adjusted point estimate (RR 0.96, 95% CI 0.59 to 1.58).

We could not obtain data suitable for analysis for constipation or ileus.

1.4.b Pulmonary: pneumonia, bronchitis

No included studies reported this outcome.

1.4.c Cardiovascular: hypotension, myocardial infarction, blood loss and blood transfusion

Four trials (150 participants) reported on the risk of hypotension (RR 0.95, 95% CI 0.50 to 1.81; I^2 0%) (Becchi 2008; Siddiqui 2007; Singelyn 2005; Utebey 2009). Egger's regression intercept showed no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method showed no evidence of publication bias.

We could not obtain data suitable for analysis for myocardial infarction.

Based on data from eight trials (323 participants), we did not find differences for intra-operative blood loss (MD -52.47 mL, 95% CI -170.88 to 65.95; I^2 79%; Analysis 1.12) (Cucoreanu Badica 2010; Kratz 2015; Nishio 2014; Siddiqui 2007; Stevens 2000; Twyman 1990; Utebey 2009; Wiesmann 2014). Egger's regression intercept showed no evidence of small-study effect. Data for amount of blood transfused were available for three trials (Nicholson 2002; Singelyn 2005; Utebey 2009; 82 participants) (MD -0.59 units, 95% CI -1.25 to 0.08; I^2 48%; Analysis 1.13).

1.4.d Neurological: acute confusional state, drowsiness, cerebrovascular accident, postoperative cognitive dysfunction

Only Marino 2009 provided results for acute confusional state (RR 0.10, 95% CI 0.02 to 0.54). Marino 2009 was judged as at low risk of bias for random sequence generation, incomplete outcome data (attrition bias), selective reporting (reporting bias) and other bias; at unclear risk of bias for allocation concealment and blinding of outcome assessment; and as at high risk of bias for blinding of participant or blinding of personnel taking care of the participant. The number needed to treat for an additional beneficial outcome (NNTB) = 12 (95% CI 11 to 22). In a large trial, 3158 participants (1579 per group) would be required to eliminate a 25% difference (alpha 0.05; beta 0.2; 1-sided test).

For grade of the evidence for reduced risk of confusional state, we downgraded by two levels because the included trial was at unclear risk of bias for allocation concealment and blinding of outcome assessor and as at high risk for blinding of participant or blinding of personnel taking care of the participant. Inconsistency and publication bias could not be assessed. The trial was a direct comparison. We downgraded the quality by two levels because the optimal information was not achieved (low number of trials/participants). We rated the level as very low.

Three trials (Jensen 2012; Köroğlu 2008; Nishio 2014; 86 participants) provided results for drowsiness (sedated) up to 48 hours (RR 0.40, 95% CI 0.13 to 1.18; I^2 0%; Analysis 1.14). Egger's regression intercept showed no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to left of mean for an adjusted point estimate (RR 0.39, 95% CI 0.14 to 1.06). Based on an incidence of 26% of excessive sedation (drowsiness) in the control groups, 1304 (652 per group) would be required in a large trial to eliminate a 25% difference (alpha 0.05; beta 0.2; 2-sided test).

We found no data suitable for analysis for cerebrovascular accident or postoperative cognitive dysfunction.

1.4.e Thromboembolic complications: deep venous thrombosis or pulmonary embolism

We could not obtain data suitable for analysis for deep venous thrombosis.

Chen 2015 reported no pulmonary emboli in 88 participants.

1.4.f Other medical complications

1.4.f.1 Risk of pruritus

Four trials (Goytizolo 2016; Köroğlu 2008; Marino 2009; Siddiqui 2007; 379 participants) reported on the risk of pruritus during the first 48 hours after surgery (RR 0.34, 95% CI 0.09 to 1.27; I^2 66%; Analysis 1.15). Random sequence generation was judged as at low risk for Goytizolo 2016; Köroğlu 2008; Marino 2009 and Siddiqui 2007. Allocation concealment was judged as at low risk for Goytizolo 2016 and Siddiqui 2007; and as at unclear risk for Köroğlu 2008 and Marino 2009. Blinding of participant and/or personnel taking care of the participant was judged as at low risk of bias for Köroğlu 2008; as at unclear risk for Goytizolo 2016 and as at high risk of bias for Marino 2009 and Siddiqui 2007. Blinding of outcome assessment was judged as at low risk for Goytizolo 2016 and Köroğlu 2008; as at unclear risk for Marino 2009; and as at high risk for Siddiqui 2007. Incomplete outcome data (attrition bias) was judged as at low risk for Goytizolo 2016; Köroğlu 2008; Marino 2009 and Siddiqui 2007. Selective reporting (reporting bias) was judged as at low risk for Goytizolo 2016; Köroğlu 2008; Marino 2009 and Siddiqui 2007. Other bias were judged as at low risk for Goytizolo 2016; Köroğlu 2008; Marino 2009 and Siddiqui 2007. Egger's regression intercept showed no significant evidence of small-study effect (2-sided test). Analysis using Duval and Tweedie's trim and fill method indicated imbalance of two trials missing to right of mean for an adjusted point estimate (RR 0.85, 95% CI 0.25 to 2.81; random-effects model). The risk was reduced when continuous block was used (RR 0.16, 95% CI 0.04 to 0.70; I^2 31%; 2 trials, 259 participants) but not when single injection block was used (RR 0.92, 95% CI 0.50 to 1.68; I^2 0%). Considering a basal rate of 20% (control group), the NNTB for continuous nerve blocks would be 4 (95% CI 4 to 8). Considering a basal rate of 20%, 1428 participants (714 per group) would be required in a large trial to eliminate a 25% difference (alpha 0.05; beta 0.2; 1-sided test).

For grade of evidence for reduced risk of pruritus for continuous nerve blocks, we downgraded by two levels for risk of bias because 75% of the included trials were judged as at unclear/high risk for allocation concealment and/or blinding of outcome assessors. There was no significant inconsistency for this subgroup (I^2 < 50%). We included direct comparisons only. We downgraded the level by one because the optimal information size was not achieved. Publication bias could not be assessed. We rated the level of evidence as very low.

1.4.f.2 Risk of respiratory depression

Three trials (Becchi 2008; Siddiqui 2007; Wiesmann 2014; 184 participants) reported risk of respiratory depression (RD -0.01, 95% CI -0.05 to 0.03; I^2 0%). Egger's regression intercept showed no significant evidence of small-study effect (2-sided test). Analysis using Duval and Tweedie's trim and fill method showed no evidence of publication bias.

1.5 Use of resources

1.5.a Hospital length of stay

Three trials (Marino 2009; Singelyn 2005; Thybo 2016; 348 participants (the forest plot (Analysis 1.17) displays 349 participants due to subgroup division) reported length of hospital stay (SMD -0.56, 95% CI -0.91 to -0.21; I^2 54%; Analysis 1.17) (Marino 2009 (2 subgroups); Singelyn 2005; Thybo 2016). Random sequence generation was judged as at low risk for Marino 2009; Singelyn 2005 and Thybo 2016. Allocation concealment was judged as at low risk for Thybo 2016; and as at unclear risk for Marino 2009 and Singelyn 2005. Blinding of participant and/or personnel taking care of the participants was judged as at low risk for Thybo 2016 and as at high risk for Marino 2009 and Singelyn 2005. Blinding of outcome assessment for judged as at low risk for Thybo 2016; and as at unclear risk of bias for Marino 2009 and Singelyn 2005. Incomplete outcome data, selective reporting and other bias were judged as at low risk for Marino 2009; Singelyn 2005; and as at unclear risk for Thybo 2016. Egger's regression intercept showed no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to right of mean for an adjusted point estimate (SMD -0.46, 95% CI -0.78 to -0.13; random-effects model). Continuous femoral nerve or psoas compartment blocks reduced length of hospital stay (SMD -0.75, 95% CI -1.02 to -0.48; I^2 0%). We found no effect from single injection femoral lateral cutaneous nerve block (SMD -0.13, 95% CI -0.52 to 0.26). Taking one study (Marino 2009; SD of control 1 day), the difference would be equivalent to 0.75 day.

We assessed evidence quality of continuous block only for hospital length of stay. We downgraded the level by two because 75% or more of the included trials were rated as unclear/high risk for allocation concealment and/or blinding of outcome assessor. There was no inconsistency for this subgroup. We included direct comparisons only. We downgraded by one level for low number of trials included. Publication bias could not be assessed. We rated the level of evidence as very low.

1.5.b Costs of treatment

We could not obtain data suitable for analysis for this outcome.

1.5.c Re-hospitalization due to pain

We could not obtain data suitable for analysis for this outcome.

1.5.d Re-hospitalization due to any other reason, including re-operation

We could not obtain data suitable for analysis for this outcome.

1.6 Quality of life, assessed with SF-36, Sickness Impact Profile, or other quality-of-life scales

We could not obtain data suitable for analysis for this outcome.

1.7 Short-term rehabilitation milestones (within six weeks after surgery)

1.7.1 Time to start rehabilitation, e.g. time to sit up in bed

Thybo 2016 (60 participants) provided results for time to first mobilization (SMD -0.30, 95% CI -0.81 to 0.22).

1.7.2. Time to achieve rehabilitation milestones, e.g. transfer unassisted in and out of bed and ability to walk unassisted with a walker on a level surface

1.7.2.1 Walking

Based on data from two trials (Green 2014; Marino 2009; 272 participants) we did not find a difference in numbers of participants who walked on postoperative day 1: (RD 0.01, 95% CI -0.03 to 0.05; I^2 0%; Analysis 1.18). Random sequence generation, incomplete outcome data, selective reporting and other bias were judged as at low risk for Green 2014 and for Marino 2009. Allocation concealment was judged as at unclear risk for Green 2014 and for Marino 2009. Blinding of participant and/or personnel taking care of participant was judged as unclear risk for Green 2014 and as at high risk for Marino 2009. Blinding of outcome assessment was judged as at low risk for Green 2014 and as at unclear risk for Marino 2009. Marino 2009 also reported results for numbers of participants who could walk more than 12.2 m at 48 hours (RR 0.51, 95% CI 0.03 to 7.88) for continuous femoral nerve block and (RR 11.15, 95% CI 0.67 to 184.61) for continuous psoas compartment block (P value for heterogeneity between subgroups 0.12). Given that an overall percentage of 11% of participants were able to walk more than 12.2 m at 48 hours, 618 participants (309 per group) would be required in a large trial to eliminate a difference of 50% (alpha 0.05; beta 0.2; 1-sided test).

We rated the level of evidence for number of participants who could walk on postoperative day 1. We downgraded the level by two for risk of bias because 75% of included trials were at unclear/high risk for allocation concealment and/or blinding of outcome assessor. There was no inconsistency. We included direct comparisons only. We downgraded by one level for imprecision. Publication bias could not be assessed. We rated the evidence as very low.

1.7.2.2 Hip flexion

Two trials (Biboulet 2004 - two subgroups; Singelyn 2005; 68 participants) reported results for hip flexion at seven days after surgery (MD -1.40°, 95% CI -9.04° to 6.25°; I^2 43%; Analysis 1.19).

1.7.2.3 Delayed rehabilitation

Nishio 2014 reported delayed rehabilitation due to drowsiness for 1/10 participants receiving continuous femoral nerve blocks versus 5/18 participants for systemic analgesia (RR 0.28, 95% CI 0.04 to 2.06).

1.8 Patient satisfaction on VAS, NRS, or other similar scales, or on ordinal or qualitative scales (FACES)

Köroğlu 2008 (30 participants) reported a higher satisfaction score with single injection femoral nerve block (SMD, 1.65 95% CI 0.83 to 2.48).

Four trials (Marino 2009; Siddiqui 2007; Singelyn 2005; Striebel 1993; 362 participants) (the forest plot (Analysis 1.20) displays 363 due to subgroup division) reported a higher satisfaction score with continuous peripheral nerve blocks (SMD 0.67 (95% CI 0.45 to 0.89; I^2 13%; Analysis 1.20). Random sequence generation was judged as at low risk for Marino 2009; Siddiqui 2007; Singelyn 2005 and Striebel 1993. Allocation concealment was judged as at low risk for Siddiqui 2007 and as at unclear risk for Marino 2009; Singelyn 2005 and Striebel 1993. Blinding of participant and/or personnel taking care of the participant was judged as at high risk of bias for Marino

2009; Siddiqui 2007; Singelyn 2005 and Striebel 1993. Blinding of outcome assessment was judged as at unclear risk for Marino 2009; Singelyn 2005 and Striebel 1993; and as at high risk for Siddiqui 2007. Incomplete outcome data, selective reporting and other bias were judged as at low risk for Marino 2009; Siddiqui 2007; Singelyn 2005 and Striebel 1993. Egger's regression intercept showed no evidence of small-study effect; and Duval and Tweedie's trim and fill analysis showed no evidence of publication bias. Taking Marino 2009 (control group SD = 3.5), the difference would be equivalent to 2.4 on a scale from 0 to 10. Based on the same trial, 50 participants (25 per group) would be required in a large trial to eliminate a difference of 2 (from 9 to 7 on a scale from 0 to 10) (alpha 0.05; beta 0.2; 2-sided test).

We rated the quality of evidence for continuous peripheral nerve blocks. We downgraded by two levels for risk of bias because 75% or more of the trials were judged as at unclear/high risk for allocation concealment and/or blinding of outcome assessor. There was no significant inconsistency. We included direct comparisons only. The optimal information size was achieved. The was no evidence of publication bias. We rated the evidence as low.

2. Comparison 2: Peripheral nerve block versus neuraxial block for postoperative analgesia

Primary outcomes

2.1 Participant-reported pain at rest and with movement on VAS, numeric rating scale (NRS), or other similar scales or on ordinal or qualitative scales (FACES)

2.1.1 Pain at rest and with movement on arrival in the postoperative care unit

Fredrickson 2015 (50 participants) compared single injection psoas compartment block with 40 mL 0.5% bupivacaine to single injection spinal injection of 2 mL bupivacaine 0.5% with morphine 0.1 mg. Worst pain scores at rest in the postoperative care unit were higher for participants who received psoas compartment block (SMD 0.99, 95% CI 0.41 to 1.58).

Four trials (Bichel 1998; Duarte 2009; Türker 2003; Utebey 2009; 118 participants) compared continuous femoral nerve block (Bichel 1998), continuous psoas compartment block (Duarte 2009; Türker 2003), or repeated dose psoas compartment block (Utebey 2009) with epidurals. Random sequence generation and allocation concealment were judged as at low risk of bias for Duarte 2009 and as at unclear risk for Bichel 1998; Türker 2003 and Utebey 2009. Blinding of participant and/or personnel taking care of the participants was judged as at unclear risk for Duarte 2009 and Türker 2003; and as at high risk of bias for Bichel 1998 and Utebey 2009. Blinding of outcome assessment was judged as at low risk for Duarte 2009; Türker 2003; and as at unclear risk for Bichel 1998 and Utebey 2009. Incomplete outcome data was judged as at low risk for Bichel 1998; Duarte 2009; Türker 2003 and Utebey 2009. Selective reporting was judged as at low risk for Bichel 1998; Türker 2003 and Utebey 2009; and as at high risk for Duarte 2009. Other bias were judged as at low risk for Bichel 1998; Türker 2003 and Utebey 2009; and as at unclear risk for Duarte 2009. We found no difference for pain at rest on arrival in the postoperative care unit (MD 0.39 95% CI -0.15 to 0.94; I^2 0%; Analysis 2.1). There was no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to the right of mean for an adjusted point estimate (MD 0.40, 95% CI -0.14

to 0.94). In Türker 2003, participants had partial hip replacement. There was no mention concerning hip fracture in the report but this intervention is often performed for patients with hip fracture. We were unable to contact the authors to establish with certainty if participants had hip fracture. When Türker 2003 was excluded from the analysis, MD was 0.41 (95% CI -0.47 to 1.29; I^2 0%). Based on results reported by Duarte 2009 (control group SD = 3.3), 76 participants (38 per group), would be required in a large trial to decrease pain scores from 5.5 to 4.

For the level of evidence for continuous block or repeated dose, we downgraded by one level for risk of bias because 50% or more of the included trials were judged as being unclear/high risk for allocation concealment and/or blinding of outcome assessor. The optimal information size was achieved. Correcting for the possibility of publication bias would not change the conclusion. We rated the quality of evidence as moderate.

Two trials compared continuous femoral nerve (Bichel 1998) or psoas compartment block (Türker 2003) with continuous epidural for pain with movement. We did not find a difference for pain with movement on arrival in the postoperative care unit (MD 0.08, 95% CI -0.46 to 0.62; I^2 23%; fixed-effect model; Analysis 2.2). When Türker 2003 was excluded from the analysis, MD was 0.43 (95% CI -0.37 to 1.23).

2.1.2 Pain at rest and with movement from 0.5 to 2 hours after surgery

Two trials (Celidonio 2008; Forget 2009; 66 participants) compared single injection fascia iliaca block with single injection epidural block (Forget 2009), or continuous femoral nerve block with or without the addition of single parasacral sciatic nerve block with continuous epidural (Celidonio 2008). Pain at rest from 0.5 to 2 hours after surgery was higher when femoral nerve or fascia iliaca block without parasacral nerve block was used (MD 3.45, 95% CI 2.01 to 4.90; I^2 30%; Analysis 2.3).

Pain with movement at two hours was higher regardless of whether parasacral sciatic nerve block was provided (MD 1.54, 95% CI 0.56 to 2.52) or not (3.50; 95% CI 1.99 to 5.01) (Celidonio 2008).

2.1.3 Pain at rest and with movement from 4 to 6 hours after surgery

Nine trials (398 participants) reported pain at rest from 4 to 6 hours after surgery. Four trials studied a continuous femoral nerve block (alone: Celidonio 2008 1 subgroup; Bichel 1998; Singelyn 2005 or with a parasacral sciatic nerve block: Celidonio 2008 (1 subgroup)). Two trials studied a fascia iliaca block (Borisov 2012; Forget 2009). Three trials studied a psoas compartment block (Duarte 2009; Souron 2003; Türker 2003). Peripheral nerve blocks were compared with an epidural (single injection: Forget 2009; continuous: Bichel 1998; Borisov 2012; Celidonio 2008; Duarte 2009; Singelyn 2005; Türker 2003) in six trials. Two trials compared peripheral nerve blocks with an intrathecal injection. The intrathecal injection contained opioids only in one trial (Souron 2003) or opioids plus a local anaesthetic (Kearns 2011).

Pain was higher with peripheral nerve blocks (SMD 0.41, 95% CI 0.11 to 0.71; I^2 49%; Analysis 2.4). There was no statistically significant evidence of small-study effect, nor significant evidence of publication bias (random-effects model). When Türker 2003 was excluded from the analysis MD was 0.43 (95% CI 0.10 to 0.75; I^2 53%). Excluding Forget 2009 (where piritramide consumption at 1 hour was higher for the peripheral nerve block group: 7.3 ± 3.5 versus 1.8

± 3.7 mg), SMD was 0.55 (95% CI 0.34 to 0.76; I^2 0%). Taking Singelyn 2005 (control group SD = 2.4), this would be equivalent to 1.3.

Seven trials (325 participants) reported results for pain with movement at 4 to 6 hours for continuous femoral nerve block (Bichel 1998; Celidonio 2008; Singelyn 2005), continuous femoral nerve block plus single injection parasacral nerve block (Celidonio 2008), fascia iliaca block (single injection: Kearns 2011; continuous block: Borisov 2012) or continuous psoas compartment block (Duarte 2009; Türker 2003) compared with continuous epidural (Bichel 1998; Borisov 2012; Celidonio 2008; Duarte 2009; Singelyn 2005; Türker 2003) or single injection intrathecal injection of an opioid and a local anaesthetic (Kearns 2011).

Pain with movement at 4 to 6 hours after surgery was higher when a peripheral nerve block was used (SMD 0.53, 95% CI 0.20 to 0.86; I^2 48%; Analysis 2.5). There was no evidence of small-study effect nor publication bias (random-effects model). When Türker 2003 was excluded from the analysis, MD was 0.63 (95% CI 0.33 to 0.93; I^2 29%). The effect size was inversely proportional to the concentration of the local anaesthetic injected as the loading dose, i.e. the difference between the two treatment groups was lower when higher concentrations were used (Figure 6; $P = 0.003$). Taking Duarte 2009 as a measure of variance (control group SD = 3.0), the difference would be equivalent to 1.6.

Figure 6. Comparison peripheral nerve block versus neuraxial block. Meta-regression analysis of the concentration of local anaesthetic in the initial loading dose in lidocaine equivalent versus pain with movement at 4 to 6 hours after surgery. The higher the concentration, the lower was the difference between the treatment groups ($P = 0.003$)

2.1.4 Pain at rest and with movement at 24 hours after surgery

Eight trials (328 participants) evaluated pain at rest at 24 hours with single injection fascia iliaca (Forget 2009; Kearns 2011), psoas compartment block (Frassanito 2008), continuous femoral nerve block (Bichel 1998; Celidonio 2008; Singelyn 2005), continuous femoral nerve block plus single injection parasacral nerve block (Celidonio 2008) or continuous psoas compartment block (Duarte 2009; Türker 2003) compared with single injection epidural (Forget 2009) or intrathecal injection of an opioid plus a local anaesthetic (Kearns 2011; Frassanito 2008) or continuous epidural (Bichel 1998; Celidonio 2008; Duarte 2009; Singelyn 2005; Türker 2003). At 24 hours, we did not find a difference between the analgesic techniques for pain at rest (SMD 0.10, 95% CI -0.22 to 0.42; I^2 45%; Analysis 2.6). There was no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to left of mean for an adjusted point estimate 0.04 (95% CI -0.27 to 0.35; random-effects model). When Türker 2003 was excluded from the analysis MD would be 0.08 (95% CI -0.28 to 0.44; I^2 51%). Results for pain were given on a scale from 0 to 4 where 0 = no pain; 1 = light pain; 2 = moderate pain; 3 = significant pain; 4 = unbearable level of pain in Bichel 1998. Analysis

excluding Bichel 1998 indicated SMD 0.20 (95% CI -0.03 to 0.43; I^2 0%).

Seven trials (217 participants) reported results for pain with movement at 24 hours for continuous femoral nerve block (Bichel 1998; Celidonio 2008; Singelyn 2005), continuous femoral nerve block plus single injection parasacral sciatic nerve block (Celidonio 2008), continuous psoas compartment block (Duarte 2009; Fredrickson 2015; Türker 2003) or single injection fascia iliaca block (Kearns 2011) compared with continuous epidural (Bichel 1998; Celidonio 2008; Duarte 2009; Singelyn 2005; Türker 2003) or with single intrathecal injection of a local anaesthetic plus an opioid (Fredrickson 2015; Kearns 2011). We did not find a difference between peripheral nerve blocks and neuraxial blocks for pain with movement at 24 hours (SMD 0.28, 95% CI -0.06 to 0.62; I^2 51%; Analysis 2.7) and no statistically significant evidence of small-study effect nor publication bias. When Türker 2003 was excluded from the analysis, MD was 0.37 (95% CI 0.03 to 0.71; I^2 43%).

2.1.5 Pain at rest and with movement at 48 hours after surgery

Seven trials (289 participants) evaluated pain at rest at 48 hours and compared continuous femoral nerve block (Bichel 1998; Celidonio

2008; Singelyn 2005), continuous femoral nerve block with the addition of single injection parasacral sciatic nerve block (Celidonio 2008), continuous psoas compartment block (Duarte 2009; Türker 2003) or single injection fascia iliaca block (Duarte 2009; Türker 2003) with continuous epidural (Bichel 1998; Celidonio 2008; Duarte 2009; Singelyn 2005; Türker 2003), or with single injection epidural (Forget 2009) or with single injection intrathecal injection of an opioid plus local anaesthetic (Kearns 2011). We did not find a difference between the two analgesic techniques (SMD 0.07, 95% CI -0.16 to 0.31; I^2 22%; Analysis 2.8) and there was no statistically significant evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of two trials missing to left of mean for an adjusted point estimate (SMD -0.01, 95% CI -0.23 to 0.21; fixed-effect model). When Türker 2003 was excluded from the analysis, MD was 0.04 (95% CI -0.21 to 0.29; I^2 26%).

Seven trials evaluated pain with movement at 48 hours after surgery. Of these, only five (164 participants) were continuous peripheral nerve blocks: femoral nerve block with (Celidonio 2008) or without the addition of single injection parasacral sciatic nerve block (Bichel 1998; Celidonio 2008; Singelyn 2005) or psoas compartment block (Duarte 2009; Türker 2003) with continuous epidural as the comparator. We did not find a difference between the modalities (SMD 0.33, 95% CI -0.13 to 0.79; I^2 50%; Analysis 2.9) nor statistically significant evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to left of mean for an adjusted point estimate (SMD 0.21, 95% CI -0.24 to 0.67; random-effects model). When Türker 2003 was excluded from the analysis, MD was 0.41 (95% CI -0.12 to 0.94; I^2 54%). Neuraxial block was however associated with better pain control when a ropivacaine infusion was used in the peripheral nerve block (SMD 0.80, 95% CI 0.36 to 1.24; I^2 0%; P value for heterogeneity between subgroups (ropivacaine versus bupivacaine) = 0.003).

2.2 Total number of nerve block-related complications (e.g. erythema, damage to surrounding structures, allergic reactions, infections, transient and lasting neurological damage)

Five trials (Aksoy 2014; Borisov 2012; Fredrickson 2015; Kearns 2011; Souron 2003; 334 participants) reported results for block-related complications (any of the following: erythema, damage to surrounding structures, allergic reactions, infections, transient and lasting neurological damage): RD: 0.00 (95% CI -0.05 to 0.05; I^2 0%; Analysis 2.10). Random sequence generation and allocation concealment were judged as at low risk for Aksoy 2014; Borisov 2012; Fredrickson 2015; Kearns 2011 and Souron 2003. Blinding of participant and/or personnel taking care of the participant was judged as at unclear risk for Kearns 2011 and Souron 2003 and as at high risk for Aksoy 2014; Borisov 2012; Fredrickson 2015. Blinding of outcome assessment for judged as at low risk for Aksoy 2014; Kearns 2011 and Souron 2003; as at unclear risk for Borisov 2012; and as at high risk for Fredrickson 2015. Incomplete outcome data and selective reporting were judged as at low risk for Aksoy 2014; Borisov 2012; Fredrickson 2015; Kearns 2011 and Souron 2003. Other bias were judged as at low risk for Fredrickson 2015; Kearns 2011 and Souron 2003; and as at unclear risk of bias for Aksoy 2014 and Borisov 2012. There was no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to right of mean for an adjusted point estimate (RD 0.01, 95% CI -0.02 to 0.04). Based on 5% incidence, a

large trial would need to include 6620 participants (3310 per group) to eliminate a 25% difference (α 0.05; β 0.2; 1-sided test).

For quality of evidence for total number of nerve block-related complications, we did not downgrade for risk of bias because less than 50% was judged as at high/unclear risk for allocation concealment and/or blinding of outcome assessors. There was no inconsistency. We used direct comparisons only. We downgraded by two levels for imprecision due to a very low number of participants included. We did not downgrade for publication bias because applying a correction for a potential one would not modify the conclusion. We rated the quality as low.

Secondary outcomes

2.1 Analgesic requirements

Four trials (Bhatia 2008; Frassanito 2008; Souron 2003; Utebey 2009; 203 participants) reported an higher dose opioids with psoas compartment blocks (single injection blocks: Frassanito 2008; Souron 2003; repeated doses: Bhatia 2008; Utebey 2009) compared with single injection intrathecal injection of an opioid (Souron 2003), with an opioid plus a local anaesthetic (Bhatia 2008; Frassanito 2008) or with a repeated doses epidural (Utebey 2009) (SMD 0.67, 95% CI 0.04 to 1.31; I^2 77%; Analysis 2.11). There was no statistically significant evidence of small-study effect nor publication bias. The effect was clearer when single injection peripheral nerve blocks were compared to single injection intrathecal injections (P value for heterogeneity between subgroups 0.003; Analysis 2.11).

2.2 Minimal clinically important improvement in pain

A mean difference of 2 or more between peripheral nerve blocks and neuraxial blocks was found for pain at rest and with movement (without the addition of a parasacral sciatic nerve block) from 0.5 to 2 hours after surgery (Analysis 2.3).

2.3 Complications related to specific method of treatment

See Table 1

2.3.1 Complications from peripheral nerve blocks

Five non functional catheters were reported: no analgesia with a fascia iliaca block (Borisov 2012; n = 1), kinked catheters with psoas compartment blocks (Türker 2003; n = 2) and psoas compartment block catheter occlusions (blood clots) (Marino 2009; n = 2). Epidural extension of psoas compartment block was reported in Biboulet 2004 (n = 4), Frassanito 2008 (n = 1), Marino 2009 (n = 5), Stevens 2000 (n = 3) and Utebey 2009 (n = 2). Two vascular punctures during psoas compartment blocks were reported by Souron 2003. Six transient neurological symptom events suggestive of local irritation were reported by Fredrickson 2015 after psoas compartment blocks. Kearns 2011 reported a transient femoral nerve palsy that resolved at three months following single injection ultrasound guided (out-of-plane technique) fascia iliaca block.

2.3.2 Complications from neuraxial blocks

Fredrickson 2015 reported transient neurological symptoms suggestive of local irritation (n = 8 for spinal anaesthesia). Six epidural catheters problems were reported: five contralateral analgesia (Singelyn 2005; n = 3 and Türker 2003; n = 2) and one kinked catheter (Türker 2003). Fredrickson 2015 also reported two inpatient falls with intrathecal morphine.

2.4 General medical complications within six weeks after surgery

2.4.a Gastrointestinal: nausea and vomiting, constipation, ileus

Data were provided in two trials ([Fredrickson 2015](#); [Souron 2003](#); 30 participants). We did not find a difference for vomiting ([Souron 2003](#)) or postoperative nausea and vomiting ([Fredrickson 2015](#)) (RR 0.79, 95% CI 0.44 to 1.39; I^2 0%; [Analysis 2.12](#)).

2.4.b Pulmonary: pneumonia, bronchitis

None of the included studies reported these outcomes.

2.4.c Cardiovascular: hypotension, myocardial infarction, blood loss and blood transfusion

Eight trials ([Aksoy 2014](#); [Bhatia 2008](#); [Frassanito 2008](#); [Kearns 2011](#); [Singelyn 2005](#); [Souron 2003](#); [Türker 2003](#); [Utebey 2009](#); 429 participants) reported on hypotension. We did not find a difference in risk of hypotension (RD -0.09, 95% CI -0.22 to 0.03; I^2 83%; [Analysis 2.13](#)). Egger's regression intercept showed no statistical evidence of small-study effect (2-sided test). Analysis using Duval and Tweedie's trim and fill method indicated imbalance of two trials missing to right of mean for an adjusted point estimate (RD -0.02, 95% CI -0.13 to 0.10; random-effects model). When [Türker 2003](#) was excluded from the analysis, RD was -0.05 (95% CI -0.16 to 0.06; I^2 78%). Hypotension risk decreased when peripheral nerve blocks were compared to continuous neuraxial blocks (RD -0.34, 95% CI -0.48 to -0.20; 3 trials, 113 participants; I^2 0%; NNTB = 4, 95% CI 3 to 6).

[Aksoy 2014](#) (70 participants) reported no myocardial infarctions.

Five trials ([Aksoy 2014](#); [Bichel 1998](#); [Duarte 2009](#); [Türker 2003](#); [Utebey 2009](#); 188 participants) reported intra-operative blood loss (MD -8.84 mL, 95% CI -80.82 to 63.14 mL; I^2 83%; [Analysis 2.14](#)) with no statistically significant evidence of small-study effect (2-sided test). Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to left of mean for an adjusted point estimate -0.04 (95% CI -0.71 to 0.63; random-effects model). When [Türker 2003](#) was excluded from the analysis, MD was -22.75 (95% CI -109.88 to 64.38; I^2 87%), and when [Utebey 2009](#) was excluded, MD was 39.94 mL (95% CI 18.05 to 61.84 mL; I^2 0%).

Three trials with 87 participants provided results for intra-operative ([Utebey 2009](#)) or total number of units transfused ([Duarte 2009](#); [Singelyn 2005](#)) (MD -0.23 units, 95% CI -0.65 to 0.19 units; I^2 33%; [Analysis 2.15](#)). There was no statistically significant evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of two trials missing to right of mean for an adjusted point estimate (MD 0.10 unit, 95% CI -0.36 to 0.55 unit; random-effects model).

2.4.d Neurological: acute confusional state, drowsiness, cerebrovascular accident, postoperative cognitive dysfunction

[Fredrickson 2015](#) (50 participants) evaluated the number of participants with confusion at 48 hours (RR 0.29, 95% CI 0.01 to 6.69). For [Fredrickson 2015](#), random sequence generation, allocation concealment, incomplete outcome data, selective reporting and other bias were judged as at low risk of bias and blinding of participant, personnel taking care of the participant and outcome assessment were judged as at high risk of bias.

We downgraded the quality of evidence for acute confusional state by one level for risk of bias for absence of blinding of outcome assessor. Inconsistency and publication bias could not be assessed. The trial is a direct comparison. We downgraded the quality by two levels for imprecision. We rated the quality as very low.

Three trials (176 participants) evaluated drowsiness at 1 hour ([Forget 2009](#)) or up to 48 hours after surgery ([Kearns 2011](#); [Souron 2003](#)) (RD 0.04, 95% CI -0.07 to 0.15; I^2 75%; [Analysis 2.16](#)). There was no statistically significant evidence of small-study effect nor publication bias (random-effects model).

[Aksoy 2014](#) (70 participants) measured mini mental tests 24 hours after surgery (SMD 0.05, 95% CI -0.42 to 0.52).

2.4.e Thromboembolic complications: deep venous thrombosis or pulmonary embolism

Two trials ([Aksoy 2014](#); [Türker 2003](#)) with 100 participants reported no deep venous thrombosis.

[Aksoy 2014](#) (70 participants) assessed pulmonary embolism and reported no events.

2.4.f Other medical complications

2.4.f.1 Risk of pruritus

From six trials ([Frassanito 2008](#); [Fredrickson 2015](#); [Kearns 2011](#); [Souron 2003](#); [Türker 2003](#); [Utebey 2009](#); 299 participants), peripheral nerve blocks reduced the risk of pruritus compared to neuraxial blocks (RR 0.33, 95% CI 0.19 to 0.58; I^2 0%; [Analysis 2.18](#)). Random sequence generation was judged as at low risk of bias for [Fredrickson 2015](#); [Kearns 2011](#) and [Souron 2003](#); and as at unclear risk for [Frassanito 2008](#); [Türker 2003](#) and [Utebey 2009](#). Allocation concealment was judged as at low risk of bias for [Fredrickson 2015](#); [Kearns 2011](#); [Souron 2003](#); at unclear risk for [Frassanito 2008](#); [Türker 2003](#) and [Utebey 2009](#). Blinding of participant and personnel taking care of the participants was judged as at low risk for [Türker 2003](#); as at unclear risk for [Frassanito 2008](#); [Kearns 2011](#); [Souron 2003](#); and as at high risk for [Fredrickson 2015](#) and [Utebey 2009](#). Blinding of outcome assessment was judged as at low risk for ([Frassanito 2008](#); [Kearns 2011](#); [Souron 2003](#) and [Türker 2003](#); as at unclear risk for [Utebey 2009](#); and as at high risk for [Fredrickson 2015](#). Incomplete outcome data, selective reporting and others bias were judged as at low risk of bias for [Frassanito 2008](#); [Fredrickson 2015](#); [Kearns 2011](#); [Souron 2003](#); [Türker 2003](#) and [Utebey 2009](#).

There was no statistically significant evidence of small-study effect nor publication bias (fixed-effect model). When [Türker 2003](#) was excluded from the analysis, RR was 0.33, 95% CI 0.18 to 0.61; I^2 0%). Based on an incidence rate of 26% the NNTB would be 6 (95% CI 5 to 9) and 1028 participants (514 per group) would be required in a large trial to eliminate a 25% difference (alpha 0.05; beta 0.2; 1-sided test).

For level of quality of the body of evidence for reduced pruritus, we did not downgrade for risk of bias because less than 50% of the trials were judged as at unclear/high risk of bias for allocation concealment and/or blinding of outcome assessor. There was no inconsistency. We included trials with direct comparisons only. We downgraded the level by one for imprecision because the optimal information size was not achieved. There was no evidence of publication bias. We rated the level as moderate.

2.4.f.2 Risk of respiratory depression

Based on data from four trials (Frassanito 2008; Fredrickson 2015; Kearns 2011; Souron 2003; 213 participants), we did not find a difference in the risk of respiratory depression between treatments (RD 0.01, 95% CI -0.03 to 0.05; I^2 0%; Analysis 2.19). There was no statistically significant evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to right of mean for an adjusted point estimate (RD 0.00, 95% CI -0.02 to 0.03; fixed-effect model). Considering an incidence rate of 1%, 34,318 participants (17,159 per group) would be required to eliminate a 25% difference (alpha 0.05; beta 0.2; 1-sided test).

2.5 Use of resources

2.5.a Hospital length of stay

From two trials (Duarte 2009; Singelyn 2005) with 64 participants we did not find a difference in hospital length of stay (MD 0.19 days, 95% CI -0.39 to 0.77 days; I^2 0%; Analysis 2.20). Random sequence generation was judged as at low risk of bias for Duarte 2009 and Singelyn 2005. Allocation concealment was judged as at low risk for Duarte 2009 and as at unclear risk for Singelyn 2005. Blinding of participant and/or personnel taking care of the participant was judged as at unclear risk for Duarte 2009 and as at high risk for Singelyn 2005. Blinding of outcome assessment for judged as at low risk of bias for Duarte 2009 and as at unclear risk for Singelyn 2005. Duarte 2009 was judged as at low risk for incomplete outcome data, at high risk for selective reporting and as at unclear risk for other bias. Singelyn 2005 was judged as at low risk for all those three domains.

We downgraded the level of evidence for hospital length of stay by one level for risk of bias because 50% or more of the trials were judged as at unclear/high risk for allocation concealment and/or blinding of outcome assessor. There was no inconsistency and trials were direct comparisons. We downgraded by one level for low number of trials. Publication bias could not be assessed. We rated the quality as low.

2.5.b Cost of treatment

We found no data suitable for analysis for this outcome.

2.6 Quality of life, assessed with the SF-36, Sickness Impact Profile, or other quality-of-life scales

We found no data suitable for analysis for this outcome.

2.7 Short-term rehabilitation milestones (within 6 weeks after surgery)

2.7.1 Time to start rehabilitation, e.g. time to sit up in bed

Two trials evaluated time from bed to chair while comparing a single-injection block to morphine intrathecal injection (Kearns 2011; SMD 0.41, 95% CI 0.02 to 0.80) or continuous psoas compartment block to epidural local anaesthetic and opioid infusion (Duarte 2009; SMD -0.14, 95% CI -0.75 to 0.47; Analysis 2.21).

Fredrickson 2015 provided results for numbers of participants in chairs at 24 hours (20/27 versus 19/23) or at 48 hours (26/27 versus 22/23) for peripheral nerve block versus neuraxial block, respectively.

Kearns 2011 reported results for numbers of participants becoming mobile at first attempt (38/52 versus 44/51) for peripheral nerve block versus neuraxial block, respectively.

2.7.2 Walking

From three trials (Duarte 2009; Singelyn 2005; Türker 2003) with 94 participants we did not find a difference in time to first walk (SMD -0.41, 95% CI -1.09 to 0.27; I^2 69%; Analysis 2.22). Random sequence generation was judged as at low risk of bias for Duarte 2009 and Singelyn 2005; and as at unclear risk for Türker 2003. Allocation concealment was judged as at low risk for Duarte 2009 and as at unclear risk for Singelyn 2005 and Türker 2003. Blinding of participant and personnel taking care of participant was judged as at low risk for Türker 2003; as at unclear risk for Duarte 2009; and as at high risk for Singelyn 2005. Blinding of outcome assessment was judged as at low risk for Duarte 2009 and Türker 2003; and as at unclear risk for Singelyn 2005. Incomplete outcome data was judged as at low risk for Duarte 2009; Singelyn 2005 and Türker 2003. Selective reporting was judged as at low risk for Singelyn 2005 and Türker 2003; and at high risk for Duarte 2009. Other bias were judged as at low risk for Singelyn 2005 and Türker 2003; and as at unclear risk for Duarte 2009. There was no statistically significant evidence of small-study effect (2-sided test) nor evidence of publication bias. When Türker 2003 was excluded from the analysis, MD was -0.08 (95% CI -0.49 to 0.32; I^2 0%). The comparison favoured peripheral nerve blocks when larger doses were used (P value for the meta-regression 0.03).

We downgraded the level by one because 50% or more of the trials were judged as at unclear/high risk for allocation concealment and/or blinding of outcome assessor. We did not downgrade for inconsistency because reasonable explanation was found for heterogeneity. All trials included were direct comparisons. There was no evidence of publication bias. We rated the quality as low.

Fredrickson 2015 reported numbers of participants walking at 24 hours (15/27 versus 21/23) and 48 hours (24/27 versus 21/23) for peripheral nerve block versus neuraxial block, respectively.

Duarte 2009 reported time required to wean off the walker (MD 0.00, 95% CI -1.75 to 1.75).

2.7.3 Hip flexion

Singelyn 2005 reported degree of hip flexion from postoperative days 1 to 10. Mean differences were: MD 2.00° (95% CI -12.16° to 16.16°) and 0.00° (95% CI -6.59° to 6.59°) at postoperative days three and seven, respectively.

2.7.4 Duration of physiotherapy and daily life activity

Duarte 2009 reported duration of functional physiotherapy required (MD -0.30 day, 95% CI -1.13 to 0.53 day).

Duarte 2009 also reported time required to perform activities of daily life (MD 0.30 day, 95% CI -1.20 to 1.80 day).

2.8 Patient satisfaction on VAS, NRS, or other similar scales, or on ordinal or qualitative scales (FACES)

From six trials (Borisov 2012; Frassanito 2008; Kearns 2011; Singelyn 2005; Souron 2003; Türker 2003) with 307 participants, we did not find a difference in patients satisfaction scores: (SMD 0.08, 95% CI -0.32 to 0.48; I^2 64%; Analysis 2.23). Random sequence generation was judged as at low risk of bias for Borisov 2012; Kearns 2011;

Singelyn 2005 and Souron 2003; and as at unclear risk of bias for Frassanito 2008; Türker 2003. Allocation concealment was judged as at low risk of bias for Borisov 2012; Kearns 2011 and Souron 2003; and as at unclear risk of bias for Frassanito 2008; Singelyn 2005 and Türker 2003. Blinding of participant and/or personnel taking care of the participants was judged as at unclear risk for Frassanito 2008; Kearns 2011; Souron 2003 and Türker 2003; and as at high risk for Borisov 2012 and Singelyn 2005. Blinding of outcome assessment was judged as at low risk for Borisov 2012; Frassanito 2008; Kearns 2011; Souron 2003 and Türker 2003; and as at unclear risk for Singelyn 2005. Incomplete outcome data was judged as at low risk for Borisov 2012; Frassanito 2008; Kearns 2011; Singelyn 2005; Souron 2003 and Türker 2003). Selective reporting was judged as at low risk for Borisov 2012; Frassanito 2008; Kearns 2011; Singelyn 2005; Souron 2003 and Türker 2003. Other bias were judged as at low risk for Frassanito 2008; Kearns 2011; Singelyn 2005; Souron 2003 and Türker 2003; and as at unclear risk for Borisov 2012. There

was no evidence of small-study effect. Analysis using Duval and Tweedie's trim and fill method indicated imbalance of one trial missing to left of mean for an adjusted point estimate SMD -0.05, 95% CI -0.47 to 0.38; random-effects model. When Türker 2003 was excluded from the analysis, SMD was 0.06 (95% CI -0.41 to 0.53; I^2 71%). There may be a difference between treatment modalities in favour of neuraxial blocks when continuous peripheral nerve blocks are used (SMD 0.54, 95% CI 0.16 to 0.31; Analysis 2.23; equivalent to 0.8 on a scale from 0 to 10 (taking Singelyn 2005 with an SD of 1.4 in the control group); P value for heterogeneity between subgroups = 0.008). On the other hand, meta-regression analysis showed that older participants were more likely to prefer peripheral nerve blocks than neuraxial blocks ($P = 0.001$; Figure 7). From Singelyn 2005 (control group SD = 1.4), the number of participants included was sufficient to eliminate a change from 9 to 7.

Figure 7. Comparison peripheral nerve block versus neuraxial block Meta-regression patient satisfaction versus age. Peripheral nerve block was more appreciated by older participants ($P = 0.001$). This figure was generated with Comprehensive Meta-analysis, the software expressed years with decimals.

We did not downgrade for risk of bias because fewer than 50% of the trials were judged as at unclear/high risk of bias for allocation concealment and/or blinding of outcome assessors. We did not downgrade for inconsistency because we found reasonable explanation for heterogeneity. Trials were direct comparisons. We did not downgrade for imprecision. We did not downgrade for publication bias because applying a correction would not modify the conclusion. We rated the quality as high.

3. Comparison 3: Peripheral nerve block versus local anaesthetic infiltration

We identified three ongoing trials (NCT02658149; NCT02658240; NCT02720471) and one trial published after the search (NCT02568995) comparing peripheral nerve blocks to local anaesthetic infiltration. These trials will be assessed for inclusion and results presented in a future review update if appropriate.

4. Comparison4: Peripheral nerve block versus intravenous lidocaine

One small trial (Thomas 2009), with 20 participants published in abstract form only, compared continuous femoral nerve block with intravenous infusion of lidocaine (1.5 mg/kg followed by 2 mg/kg/hour intra-operatively and 1.5 mg/kg/hour for 24 hours postoperatively). They did not find a difference for intravenous patient-controlled morphine consumption at 24 hours (MD -2.0 mg, 95% CI -18.0 to 14.0 mg). Consumption from 24 to 48 hours was higher for participants who received continuous femoral nerve block (MD 11.0 mg, 95% CI 1.4 to 20.6 mg). The study authors did not report a difference for pain scores at 24 hours (MD -0.4, 95% CI -2.1 to 1.3), 48 hours (MD 0.2, 95% CI -2.13 to 2.5) or three months (MD -0.3, 95% CI -1.1 to 0.5) nor for degree of flexion (time point unspecified).

DISCUSSION

We included 51 studies with 2793 participants in the review (1448 participants randomized to undergo peripheral nerve blocks and 1345 to control groups). Of the 51 studies, we included 45 trials (2491 participants) in the analysis (1288 - peripheral nerve blocks; 1203 - controls).

We found that peripheral nerve blocks provide better quality pain relief compared to systemic analgesia (moderate-quality evidence). The difference was equivalent to 3.2 on a scale from 0 to 10 for pain at rest on arrival in the postoperative care unit ([Summary of findings for the main comparison](#)). Pain control provided by peripheral nerve block was equivalent to neuraxial block ([Summary of findings 2](#)).

In 2000, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) suggested that pain should be considered as the fifth vital sign, and that under-treatment of pain would constitute abrogation of a fundamental human right ([White 2007](#)). After this statement was issued, an increase in the use of opioids for acute postoperative pain treatment was observed, together with increased side effects from opioid use ([White 2007](#)). It was also noted that postoperative critical respiratory events were encountered more frequently during the first 24 hours after opioid therapy was introduced ([Ramachandran 2011](#)).

We found one reported adverse event where a participant experienced respiratory depression from systemic opioids (intravenous patient-controlled analgesia with morphine; [Siddiqui 2007](#)). Fortunately, the event was without serious consequence. Finding alternatives to systemic opioids for postoperative pain treatment is a clinical goal. Ensuring that alternate treatment provides at least equal analgesia without undue increased risk of harm is imperative.

A previous Cochrane Review found that neuraxial blocks were superior to systemic analgesia for postoperative abdominal surgery pain treatment ([Guay 2016a](#)). Results from the current review confirm that peripheral nerve blocks provides superior pain control for elective primary total hip replacement (moderate-quality evidence). We found no major differences between peripheral nerve block and neuraxial blocks ([Summary of findings 2](#); moderate-quality evidence).

We included a range of peripheral nerve blocks in this Review. Although comparing efficacy among peripheral nerve block types was not an objective of this review, some results suggest a higher efficacy of psoas compartment blocks for elective hip replacement. This would seem true for pain at rest at 0.5 to 2 hours ([Analysis 1.2](#)), pain at rest and on movement at 4 to 6 hours after surgery ([Analysis 1.3](#); [Analysis 1.4](#)) and pain on movement at 24 and 48 hours ([Analysis 1.6](#); [Analysis 1.8](#)). However, although psoas compartment blocks seem relatively safe in the hands of well-trained operators ([Njathi 2017](#)), better efficacy needs to be weighed against the fact that psoas compartment blocks require a higher level of anaesthesiologist expertise ([Hargett 2005](#)) and are considered to be deep blocks making them relatively contraindicated for people with altered coagulation/haemostasis ([Horlocker 2010](#)).

Although the incidence of major complications associated with neuraxial blocks are roughly equivalent to peripheral nerve blocks (2 to 4 per 10,000; [Auroy 2002](#); [Barrington 2013](#); [Neal 2015](#);

[Orebaugh 2012](#); [Sites 2012](#)), serious adverse events associated with peripheral nerve blocks are often less devastating with better prognosis. We found one reported incidence of neurological complication that lasted for more than three months ([Siddiqui 2007](#)). This event related to a participant with prolonged prothrombin time (international normalized ratio 5.6 measured on postoperative day 3) after psoas compartment block. Psoas compartment block should be treated as a neuraxial block (deep block, not a compressible site) ([Horlocker 2010](#)). When warfarin is started before surgery, measurement of international normalized ratio before neuraxial/deep block performance is suggested ([Horlocker 2010](#)). Additional daily measurements are recommended during the time the catheter is in situ ([Horlocker 2010](#)). Catheter withdrawal is advocated when the international normalized ratio is < 1.5 ([Horlocker 2010](#)).

A transient (< 3 months) femoral nerve paresis potentially associated with an out-of-plane ultrasound-guided fascia iliaca block was reported ([Kearns 2011](#)). Although ultrasound guidance reduces inadvertent intravascular needle penetration in adults ([Lewis 2015](#)), there is no clear evidence that ultrasound guidance reduces the risk of neurological complications ([Guay 2016b](#); [Lewis 2015](#); [Neal 2015](#)). As opposed to an in-plane technique where a clear visualization of the needle shaft is required through the entire procedure, an out-of-plane needle approach offers only a glimpse of the needle tip position. Although there are scant data to guide the needle approach for ultrasound-guided regional anaesthesia for hip arthroplasty, evidence extrapolated from ultrasound-guided vascular access literature suggests that damage to surrounding structures may be reduced by using an in-plane technique ([Berk 2013](#)). Further studies on ultrasound guidance for regional blockade could be useful.

An included study reported two instances of falls by inpatients ([Fredrickson 2015](#)). Both falls occurred in participants who had received 0.1 mg morphine intrathecally. Some concerns about the risk of inpatient falls have been raised in relation to use of continuous lower limb peripheral nerve blocks for postoperative analgesia. Detailed analysis revealed that attributable risk for patients who had undergone continuous peripheral nerve block was not outside the expected probability of postoperative falls after orthopaedic surgery ([Johnson 2013](#)). A large retrospective trial found that risk for inpatient falls was higher among older patients, those with higher comorbidity burden and more major complications, but that the use of peripheral nerve blocks was not significantly associated with inpatient falls ([Memtsoudis 2014](#)). Inpatient falls occur mainly while patients are in their own rooms (while in the bathroom, going to and from the bathroom, or using a bedside commode) ([Johnson 2014](#)). Regardless of use of peripheral nerve block, fall prevention strategies should continue to provide education for all patients and reinforce practices to monitor patients in their hospital rooms ([Johnson 2014](#)).

We also found that peripheral nerve blocks may be associated with reduced risk of postoperative acute confusional state (very low quality-evidence; [Summary of findings for the main comparison](#)). The pathophysiology of acute confusional state may be multifactorial and include side effects of medications used, hypoxaemia, immobilization, infection and systemic inflammation ([Mouzopoulos 2009](#)). Peripheral nerve blocks (or local anaesthetics) may influence these factors. Further studies are

needed to confirm these findings and shed some light on the exact mechanisms involved.

Pruritus is an annoying side effect associated with opioid administration and may be challenging to treat without partial reversal of analgesic effects, especially when administered intrathecally (Alhashemi 1997). Interestingly, continuous peripheral nerve blocks reduced the risk of pruritus compared to systemic analgesia (NNTB 4, 95% CI 4 to 8; very low-quality evidence; [Summary of findings for the main comparison](#)) or neuraxial blocks (NNTB 6, 95% CI 5 to 9; moderate-quality evidence; [Summary of findings 2](#)). Compared with systemic analgesia, we speculated that continuous peripheral nerve blocks conferred a reduced risk of pruritus attributable to reduced systemic opioids (SMD -0.62, 95% CI -0.89 to -0.35; [Analysis 1.9](#)).

We also found a modest reduction of hospital length of stay associated with peripheral nerve blocks compared to systemic analgesia (equivalent to 0.75 day; very low-quality evidence). Although the reduction was relatively small, considering the large numbers of procedures performed each year (over 300,000 total hip replacements annually in the USA alone) and that projections estimate further future increases (Kurtz 2007), even a small reduction may have important economic impact. Future studies on costs would be useful.

We did not find differences in short-term rehabilitation milestones.

Compared to systemic analgesia, patient satisfaction was higher when peripheral nerve blocks were used for postoperative analgesia following primary elective hip arthroplasty (equivalent to 2.4 on a scale from 0 to 10; low-quality evidence; [Summary of findings for the main comparison](#)) and comparable to satisfaction reported for neuraxial blocks ([Summary of findings 2](#)).

Summary of main results

Compared to systemic analgesia alone, there is evidence that peripheral nerve blocks reduce postoperative pain, acute confusional status, pruritus and hospital length of stay.

Compared to neuraxial blocks, there is evidence that peripheral nerve blocks reduce pruritus.

Adverse events were rare. With peripheral nerve blocks, there were two neurological injuries (Kearns 2011; Siddiqui 2007). One injury lasted less than three months and the other one was still partially unresolved at three months. The latter might may have been caused by abnormal blood clotting. It is therefore possible that the injury that was not fully resolved at three months may have been avoidable had guidelines and recommendations regarding block placement in patients receiving medications altering blood coagulation been followed (Horlocker 2010). Two inpatient falls were reported in patients receiving morphine-like substances in the spine (Fredrickson 2015). One patient with intravenous morphine experienced respiratory depression (Siddiqui 2007).

Overall completeness and applicability of evidence

We are confident that our results reflect the actual available evidence on the benefits of peripheral nerve blocks in patients undergoing elective primary hip arthroplasty. Although techniques used in the included trials required a certain amount of expertise, they reflect contemporary clinical practice. Until recently,

peripheral nerve blocks were generally used only by a limited group of experienced practitioners. However, widespread use of ultrasound guidance technique has increased and the number of clinicians using peripheral nerve blocks for postoperative analgesia is rapidly growing.

Pain has been the most frequent outcome studied to illustrate the potential benefits of peripheral nerve blocks. The body of evidence for other important outcomes, such as reduced risk of acute confusional state, faster mobilization and reduced length of hospital stay, is still relatively sparse and could be enhanced.

Although ultrasound guidance has increased the number of anaesthesiologists providing peripheral nerve blocks to their patients, a recent study performed on 12,911,056 patients undergoing ambulatory surgery indicate that only 3.3% of the patients who could have benefited from a peripheral nerve block did indeed received one (Gabriel 2017). Authors concluded that future studies are necessary to identify barriers and disparities in care.

Quality of the evidence

We assessed the evidence according to GRADE recommendations (GRADEpro GDT) for all outcomes and presented results in 'Summary of findings' tables ([Summary of findings for the main comparison](#); [Summary of findings 2](#)).

For peripheral nerve blocks compared to systemic analgesia, the evidence quality was rated as moderate for pain, low for patient satisfaction and very low for pruritus, acute confusional state, hospital length of stay and number of participants walking at postoperative day one.

For peripheral nerve blocks compared to neuraxial blocks, the quality of evidence was rated as high for patient satisfaction, moderate for pain and pruritus, low for total number of block-related complications, hospital length of stay and time to first walk, and very low for acute confusional state.

Evidence quality was downgraded to low or very low due to flawed study designs and limited numbers of trials and participants.

Potential biases in the review process

Following an extensive search, we are confident that our results reflect the published evidence relating to nerve blocks following primary hip arthroplasty. We also think that our extensive heterogeneity exploration, based on a priori chosen factors, allowed us to draw valid conclusions on the benefits of the various peripheral nerve blocks used for elective primary hip arthroplasty. We examined the effects of interventions based on technique (psoas compartment blocks, femoral nerve blocks, fascia iliaca blocks etc.) localization methods (ultrasound or nerve stimulator guidance), drug type (lidocaine, bupivacaine, ropivacaine etc.) and doses, concentrations or administration methods (single injection versus continuous infusion). Assessments of these trial aspects are clinically relevant and strengthen review findings.

Agreements and disagreements with other studies or reviews

This is the first version of this review. Our finding that peripheral nerve blocks reduce pain compared to systemic analgesia is

consistent with other non-Cochrane reviews ([Barreveld 2013](#); [Højer Karlsen 2015](#); [Stein 2012](#)). This also stands for reductions in opioid use at 24 hours and risk of pruritus with psoas compartment blocks ([Højer Karlsen 2015](#)). A reduced length of hospital stay was also advocated by [McGraw 2012](#). In their review on the effects of peripheral nerve blocks on long-term functional outcome after elective large joint replacement, [Atchabahian 2015](#) did not detect a difference in range of motion with the use of peripheral nerve blocks for postoperative analgesia. This finding is consistent with our results; we did not detect a difference for walking on postoperative day one or for hip flexion at 7 days with peripheral nerve blockade versus systemic analgesia alone ([Summary of findings for the main comparison](#)).

AUTHORS' CONCLUSIONS

Implications for practice

Compared to systemic analgesia, peripheral nerve blocks may offer advantages: better pain treatment, reduced risk of pruritus and increased patient satisfaction. We also found limited evidence suggesting reduced risks for acute confusional state and hospital length of stay. We did not find evidence to support for numbers of patients who could walk on day one nor in the degree of hip flexion achieved at seven days.

Compared to neuraxial blocks, peripheral nerve blocks reduce the risk of pruritus. We found no evidence to support a difference in pain scores, total number of block-related complications, acute confusional state, hospital length of stay, time to first walk nor patient satisfaction.

Severe adverse events with peripheral nerve blocks are fortunately rare. Nevertheless, occurrence of one neurologic injury (lasting > 3 months) in a participant with elevated international normalized ratio levels who was receiving warfarin postoperative thromboembolism prophylaxis calls for reinforcement of strict observance of international society-approved guidelines for anticoagulation management ([Horlocker 2010](#)). The importance of implementing programs to prevent inpatient falls is also highlighted (2 participants receiving intrathecal morphine 0.1 mg fell during hospital stays).

The 11 ongoing studies, once completed, and the three studies awaiting classification may alter the conclusions of the review once assessed.

Implications for research

Further research is needed to better define the role of peripheral nerve blocks in reducing acute confusional state, length of hospital stay and costs. Although the evidence seems relatively sparse regarding potential effects of peripheral nerve blocks on short- and long-term rehabilitation, we doubt that further studies would demonstrate a substantial effect of peripheral nerve blocks on this.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Aksoy 2014

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus neuraxial block.</p> <p>Ethics committee: approved by the ethics committee of Ataturk University Medical Faculty Ethical Committee (registration number: 13, 26 December 2013).</p> <p>Informed consents: written informed consent obtained from all participants.</p> <p>Site: Department of Anaesthesiology and Reanimation, Ataturk University, Medical Faculty, Erzurum, Turkey,</p> <p>Date of data collection: 1 January 1 to 30 May 2014.</p> <p>Funding: the authors declared no competing interests, taken as departmental resources</p>
Participants	<p>80 (ASA 3 or 4) adults aged over 60 years undergoing elective hip replacement surgery.</p> <p>Exclusion criteria: adults with cognitive deficit (MMSE < 5), aged up to 60 years, and contra-indications to the regional anaesthetic techniques used such as coagulation disorder or infection at the puncture site</p>
Interventions	<p>Intervention: single injection psoas compartment and sciatic nerve block plus iliac crest infiltration (N = 35).</p> <p>All participants needed continuing infusion of propofol (2 mg/kg/h) during operation.</p> <p>Morphine 0.1 mg/kg subcutaneously at the end of surgery.</p> <p>Control: continuous spinal anaesthesia (N = 35).</p>

Aksoy 2014 (Continued)

Morphine 200 µg intrathecally at the end of surgery.

Tramadol IV as rescue analgesia.

Thromboprophylaxis with 40 mg LMWH started 12 h before surgery

Outcomes	<ul style="list-style-type: none"> • Pain at rest at 30 min, 1, 2, 4, 6, 12 and 24 h • Analgesic requirement: requiring rescue analgesia • Medical complications <ul style="list-style-type: none"> • gastrointestinal: nausea and vomiting • cardiovascular complications: myocardial infarction, hypotension (requiring ephedrine treatment which was administered for 30% decreases in systolic blood pressure) and intra-operative blood loss (weighing the sponges used during surgery plus the amount of blood in the suction bottle) • neurological complication, postoperative cognitive dysfunction: MMSE at 24 h • thromboembolic events: deep venous thrombosis and pulmonary embolism
Notes	<p>Australian New Zealand Clinical Trials Registry: ACTRN12614000658617</p> <p>Emailed authors 16 May 2016; no reply received</p> <p>DOI 10.1186/1471-2253-14-99</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"prospective randomised study... using a computer generated random number by an anaesthesiologist responsible for patient allocation"
Allocation concealment (selection bias)	Low risk	Randomized before transfer to the operating room
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"An anaesthesiologist blinded to group allocation visited the patients and postoperative side effects such as nausea, vomiting and bradycardia were recorded. Also, postoperative pain was evaluated at rest using a 10 cm VAS (0 cm = no pain; 10 cm = worst pain possible) and pain scores were recorded at 30 min and 1st, 2nd, 4th, 6th, 12th and 24th h post-operatively"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Data from 10 participants were not included in the analysis (5 in each group); three failed spinal, three insufficient analgesia with peripheral nerve blocks and 4 refusal (2 in each group)
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Unclear risk	<p>"Three patients in both groups required general anaesthesia due to failed or insufficient block, and these patients were excluded from the study". Therefore, data from these participants were not included in intention-to-treat analysis.</p> <p>Groups comparable for clinical characteristics and comorbidities</p>

Anis 2011

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia.</p> <p>Site: Ain Shams University Specialized Hospital, Cairo, Egypt.</p> <p>Date of data collection: not reported.</p> <p>Ethics committee: approved by the institutional review board.</p> <p>Informed consent: written informed consent obtained.</p> <p>Funding: unspecified</p>
Participants	<p>60 (ASA 1 or 2) adult participants aged 18 to 60 years with weight between 50 and 100 kg and height between 150 and 190 cm undergoing hip surgery.</p> <p>Exclusion criteria: pregnancy; ASA physical status > 2; neurologic disorders; hypersensitivity or known allergy to local anaesthetic or opioids; contra-indication to regional anaesthesia (local infection, sepsis, coagulation abnormality); failure to perform lumbar plexus block; refusal to participate in the study</p>
Interventions	<p>Intervention 1: single injection lumbar plexus block without clonidine (N = 20)</p> <p>Intervention 2: single injection lumbar plexus block with clonidine (N = 20)</p> <p>Control: no block (N = 20)</p> <p>All participants: general anaesthesia for surgery with midazolam, thiopental, fentanyl, nitrous oxide, halothane and atracurium</p> <p>IM morphine as rescue</p>
Outcomes	<ul style="list-style-type: none"> Pain at rest at 1, 2, 4, 6, 12 and 24 h after surgery Analgesic requirement: opioid consumption at 24 h and time to first analgesic request Local anaesthetic toxicity Medical complications <ul style="list-style-type: none"> neurological complications, drowsiness: sedation scores at 1, 2, 6, 12 and 24 h after surgery others: respiratory depression at 12 h after surgery
Notes	<p>Emailed authors 15 May 2016; no reply received</p> <p>DOI 10.1016/j.egja.2011.02.001</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomly allocated... After regaining of motor power, before recovery from inhalational anaesthetic, patients were randomly divided into three equal sized groups (A, B and C), using a series of closed envelopes"
Allocation concealment (selection bias)	Low risk	"...closed envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not mentioned

Anis 2011 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up mentioned
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Low risk	Groups were comparable

Asano 2010

Methods	Parallel RCT Comparison: peripheral nerve bloc versus neuraxial block Site: Department of Anesthesiology, Nagoya University, Nagoya, Aichi, Japan; Department of Anesthesiology, Sohag Faculty of Medicine, Sohag, Egypt Date of data collection: unspecified Ethics committee: not mentioned Informed consent: not mentioned Funding: unspecified
Participants	45 participants undergoing total hip replacement
Interventions	Intervention: continuous lumbar plexus block (N = 15) Control: continuous lumbar epidural (N = 15) All participants: IV patient-controlled analgesia with fentanyl
Outcomes	<ul style="list-style-type: none">• Pain at rest and during physiotherapy up to 72 h• Analgesic requirement: fentanyl consumption• Medical complications: gastrointestinal: vomiting• Short-term rehabilitation milestones: active hip flexion degree (time point?) and walking distance at 16, 36 and 66 h after surgery• Participant satisfaction at 48 and 66 h
Notes	Conference abstract. We could not obtain data suitable for analysis This study also included a group with continuous lumbar plexus block plus peri-articular infiltration not retained in this review Emailed authors 15 May 2016; no reply received
Risk of bias	
Bias	Authors' judgement Support for judgement

Asano 2010 (Continued)

Random sequence generation (selection bias)	Unclear risk	"...were randomized", no details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not mentioned
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not mentioned
Selective reporting (reporting bias)	Unclear risk	Results not given in the abstract
Other bias	Low risk	Demographics similar in all groups

Bakalov 2016

Methods	Parallel RCT? Comparison: peripheral nerve block versus no block Site: Department of Anesthesiology and Intensive Care, Military Medical Academy, Sofia, Bulgaria and Centre Hospitalier Nord Deux Sevres, Anesthesia, Bressuire, France Date of data collection: unspecified Ethics committee: approved by the hospital ethics committee Informed consent: not mentioned Funding: unspecified	
Participants	40 participants undergoing total hip arthroplasty	
Interventions	Intervention: quadratus lumborum block Control: no block All participants: paracetamol, ketoprofen and IV patient-controlled analgesia morphine	
Outcomes	<ul style="list-style-type: none">Analgesic requirement: morphine consumption (9.5 mg versus 28 mg; SD not provided)Medical complications: gastrointestinal: vomiting	
Notes	Conference abstract, no contact address provided	
Risk of bias		
Bias	Authors' judgement	Support for judgement

Bakalov 2016 (Continued)

Random sequence generation (selection bias)	Unclear risk	"After approval of the hospital ethical committee 2 groups of 20 patients are formed"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not mentioned
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No lost to follow-up reported
Selective reporting (reporting bias)	Unclear risk	Measurements made are not mentioned in the methods section
Other bias	Unclear risk	Conference abstract, details of blockade or side effects not reported

Becchi 2008

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: Florence University – AOUC Careggi, Florence, Italy.</p> <p>Date of data collection: March 2004 to February 2005</p> <p>Ethics committee: not mentioned</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: unspecified</p>
Participants	<p>73 participants (ASA 1 to 3) aged 61 to 82 years, undergoing total hip arthroplasty</p> <p>Exclusion criteria: contra-indications to regional anaesthesia, to NSAIDs or opioids, hepatic or renal insufficiency, alcohol or drug abuse, or dementia preventing comprehension</p>
Interventions	<p>Intervention: continuous psoas compartment block for 48 h (N = 37)</p> <p>Control: continuous intravenous infusion 0.1% morphine and 0.12% ketorolac at 2 mL/h for 48 h (N = 36)</p> <p>Spinal anaesthesia for surgery</p> <p>Rescue analgesia: IV infusion 0.8 g paracetamol increments at 6 h intervals</p>
Outcomes	<ul style="list-style-type: none"> Pain scores at rest and after mobilization at 6 h intervals for 48 h Analgesic requirement: analgesic consumption at 24 h and 48 h

Becchi 2008 (Continued)

- Medical complications
 - * gastrointestinal: nausea and vomiting
 - * cardiovascular: hypotension (requiring treatment on > 30% decrease from baseline),
 - * others: respiratory depression (rate < 10 per min, SaPO₂ < 90% and PaCO₂ > 50 mm Hg), pruritus

Notes Emailed authors 15 May 2016; no reply received

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Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"using randomization tables"
Allocation concealment (selection bias)	Unclear risk	Not mentioned. Participants were randomized by a nurse not involved in the study according to a randomization table, but no information is provided about who recruited the participants and if recruiters had access to the list
Blinding of participants and personnel (performance bias) All outcomes	High risk	No sham block
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"...assigned by a nurse not involved in the study" "The same operator performed all procedures and was not involved in the evaluation" "An infusing device (Acute Pain Manager-APMA, Abbott) delivering saline was connected to an IV line in Group A, while in Group B, an identical 20-G multi-perforated catheter was externally fixed on the back of every patient and connected to an infusion device which remained off. To guarantee the blindness of the clinical postoperative evaluator, all the infusing pumps were covered to hide the display"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Spinal anaesthesia and psoas block analgesia were successful in all participants. Lumbar plexus catheters remained functional throughout the study in all participants. One participant in both Groups A and B were excluded from the analysis for non-compliance with the rehabilitation protocol
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Unclear risk	"Both groups were matched in terms of age, gender, weight and ASA classification". Not included in intention-to-treat analysis. Results tables show 35 participants for each group

Bhatia 2008

Methods Parallel RCT

Comparison: peripheral nerve block versus neuraxial block

Site: Addebrook's Hospital, Cambridge, UK

Date of data collection: 2007 to 2009

Bhatia 2008 (Continued)

Ethics committee: approved by the ethics committee

Informed consent: written informed consent obtained from all participants

Funding: departmental resources

Participants	87 participants (ASA physical status 1 or 2) aged between 18 and 85 years scheduled for primary unilateral hip arthroplasty Surgical technique: lateral
Interventions	Intervention: double dose psoas compartment block injected before and at the end of surgery (N = 45) Control: intrathecal diamorphine (N = 42) General anaesthesia for all participants Patient-controlled analgesia with morphine Follow-up: six days
Outcomes	<ul style="list-style-type: none"> Pain at 24 h Analgesic requirements: opioid consumption at 24 h Medical complications, cardiovascular: hypotension, blood loss Medical complications, others: urinary retention Short-term rehabilitation milestones: time to mobilisation (number of physiotherapy targets achieved at postoperative day 3) Use of resources: length of hospital stay (able to perform 18/20 predefined exercises)
Notes	Conference abstract Additional information received from study authors

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Computer-generated randomization sequence"
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	"Anesthesiologist providing intraoperative care were not aware of patients' group allocation (all blocks were done in regional block room). Participants were not blinded"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Anaesthesiologist providing intraoperative care were not aware of patients' group allocation (all blocks were done in regional block room). Research nurse who followed the patient postoperatively also was not aware of group allocation."
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results reported

Bhatia 2008 (Continued)

Other bias	Low risk	"Demographic characteristics and pre-operative pain scores were similar in both groups." Preoperative pain scores 6 (6 to 8) and 7 (6 to 8) for peripheral nerve block and control group respectively
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Biboulet 2004

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: Montpellier, France Date of data collection: unspecified Ethics committee: institutional review board approval obtained Informed consent: written informed consents obtained Funding: unspecified
Participants	45 consecutive participants scheduled for elective total hip arthroplasty
Interventions	Intervention 1: single injection femoral nerve block (N = 16) Intervention 2: single injection psoas compartment block (N = 15) Control: no block (N = 14) General anaesthesia with midazolam, sufentanil, thiopental, nitrous oxide, isoflurane and atracurium for all participants' surgeries IV patient-controlled analgesia with morphine, systematic IV paracetamol 2 g every 6 h for 48 h and 50 mg indomethacin intra-rectally at the end of surgery and 25 mg orally every 12 h for 48 h
Outcomes	<ul style="list-style-type: none"> Pain at rest and on movement (passive mobilization) at 0, 4, 8, 12, 24 and 48 h Analgesic requirement: opioid consumption Medical complications, gastrointestinal: nausea and vomiting Medical complications, neurological: sedation Medical complications, others: pruritus Use of resources: hospital length of stay in rehabilitation centre (until ability to walk on an inclined plane without aid, to climb and descend 10 stairs, and acquisition of hip stability during activities of daily living) Short-term rehabilitation milestones: hip mobility at postoperative day 7
Notes	Emailed study authors 17 May 2016; no reply received DOI 10.1016/j.rapm.2003.11.006

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomized", no further details

Biboulet 2004 (Continued)

Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not mentioned
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"The assessment of analgesia and side effects was performed by an anaesthetist blinded to the participant's group"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Regarding the functional assessment, 2 participants (1 who received systemic analgesia and 1 with a femoral nerve block) were excluded for non compliance with the rehabilitation protocol
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Unclear risk	Not included in intention-to-treat analyses for all outcomes

Bichel 1998

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus neuraxial block</p> <p>Site: Hôpital Universitaire de Liège, Belgium</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: approved by the ethics committee of Hôpital Universitaire de Liège</p> <p>Informed consent: not mentioned</p> <p>Funding: unspecified</p>
Participants	<p>24 participants undergoing total hip arthroplasty</p> <p>Exclusion criteria: renal or hepatic or immune dysfunction, infectious episode within the last 15 days</p>
Interventions	<p>Intervention: continuous femoral nerve block for 24 h (N = 12)</p> <p>Control: epidural analgesia for 24 h (N = 12)</p> <p>Opioids were stopped 48 h before surgery</p> <p>General anaesthesia with sufentanil, propofol, nitrous oxide, isoflurane and atracurium for all participants.</p> <p>IV paracetamol 2 g followed by piritramide 0.3 mg/kg IM if required as rescue analgesia</p> <p>IV patient-controlled analgesia with piritramide started after catheter withdrawal</p> <p>Nadroparin started 12 h before surgery</p>
Outcomes	<ul style="list-style-type: none"> Pain at rest and on movement at 0, 6, 20, 24, 27, 30, 44 and 48 h after surgery Analgesic requirement: opioid consumption

Bichel 1998 (Continued)

- Medical complications, cardiovascular: hypotension (requiring treatment), blood loss, number of participants transfused

Notes Letter sent to study authors 17 May 2016; no reply received

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomised", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants received epidural or femoral catheters
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Low risk	Groups comparable

Borisov 2012

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus neuraxial block</p> <p>Site: Northern State Medical University, Arkhangelsk, Russia</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: not mentioned</p> <p>Informed consent: not mentioned</p> <p>Funding: unspecified</p>
Participants	<p>60 participants undergoing elective total hip arthroplasty</p> <p>Exclusion criteria: unspecified</p>
Interventions	<p>Intervention: continuous fascia iliaca block for 48 h (N = 29)</p> <p>Control: continuous epidural analgesia for 18 to 20 h (N = 29)</p> <p>Spinal anaesthesia for surgery</p>

Borisov 2012 (Continued)

Acetaminophen 4 g/day, ketoprofen (300 mg/day) for all participants

Rescue analgesia with tramadol

Follow-up 48 h

Outcomes	<ul style="list-style-type: none"> Pain at rest and on movement Analgesic requirement: tramadol consumption Medical complications, gastrointestinal: nausea and vomiting Participant satisfaction
Notes	<p>Emailed study authors 17 May 2016; no reply received</p> <p>DOI 616.728.2-089.28:617-089.5</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomised with envelopes"
Allocation concealment (selection bias)	Low risk	"...with envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants received a femoral or an epidural catheter
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	"...one patient epidural anaesthesia was stopped because of haemodynamic instability, secondary to a high volume of blood loss from wound drainage. For fascia iliaca, blockade was considered ineffective for one patient, and the infusion of local anaesthetic was stopped at 6 hours after the beginning of the study"
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Unclear risk	<p>Continuous infusion was stopped at different times (18 h to 20 h for epidural analgesia versus 48 h for fascia iliaca block). We took data from only the first 18 h for pain scores</p> <p>Not included in intention-to-treat analysis</p>

Celidonio 2008

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus neuraxial block</p> <p>Site: University Hospital of Tor Vergata, Rome, Italy</p> <p>Date of data collection: unspecified</p>
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Celidonio 2008 (Continued)

Ethics committee: approved by the ethics committee

Informed consent: obtained

Funding: unspecified

Participants	46 ASA 1 to 3 participants undergoing total hip arthroplasty
Interventions	<p>Intervention 1: continuous femoral nerve block for 48 h (N = 18)</p> <p>Intervention 2: continuous femoral nerve block for 48 h plus single injection sciatic nerve block (N = 13)</p> <p>Control: Postoperative analgesia: continuous epidural with 15 to 20 mL 0.5% ropivacaine, with sufentanil 10 mg and clonidine 1 mg/mL followed by 2 mg/mL ropivacaine and sufentanil 0.15 mg/mL at 8 mL/h for 48 h (N = 15)</p>
Outcomes	<ul style="list-style-type: none"> • Pain at rest and on movement at 2, 6, 12, 24 and 48 h • Analgesic requirements • Blood loss
Notes	Additional information received from study authors

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization was computer generated"
Allocation concealment (selection bias)	Unclear risk	"A clinician, not involved in data recording (study coordinator), was involved for the allocation concealment, enrolling each patient"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	"Patients were blind about the technique used because they were asleep during regional anaesthesia performing" "Catheters were fixed in the same way and covered with white medications in order to avoid any identification of the technique used. Data recorder was blind too about the technique performed. Only the study coordinator and the anaesthesiologist performing the chosen technique were informed"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Blind" "Catheters were fixed in the same way and covered with white medications in order to avoid any identification of the technique used. Data recorder was blind too about the technique performed. Only the study coordinator and the anaesthesiologist performing the chosen technique were informed"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up mentioned
Selective reporting (reporting bias)	Low risk	Additional information received from study authors, all results reported
Other bias	Low risk	Groups were homogenous regarding demographics, ASA status, pain scores and haemodynamics before anaesthesia, and also regarding length of surgery, haemodynamics, opioid consumption and intra-operative blood loss

Chen 2015

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: Hengshui Fifth People's Hospital, China</p> <p>Date of data collection: from January 2010 to October 2013</p> <p>Ethics committee: approved by the hospital ethics committee</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: departmental resources only</p>
Participants	<p>102 participants scheduled for total hip replacement because of joint disease without deep vein thrombosis on lower limbs by pre-operative colour Doppler ultrasonography</p> <p><i>Exclusion criteria:</i> cardiac function grade $< \text{III}$, stage 3 chronic kidney disease, acute thrombophlebitis, neurological disease on lower limbs, history of allergy to heparin or anticoagulation treatment, history of bleeding disorders or cancer</p> <p>Cemented prosthesis</p>
Interventions	<p>Intervention: continuous femoral nerve block for 72 h, LMWH plus intermittent pneumatic pressure (N = 51)</p> <p>Control: no block, LMWH or intermittent pneumatic pressure according to attending physician's preference (N = 51)</p> <p>General anaesthesia with combined IV and inhalational agents for all participants</p> <p>LMWH was started at half dose 6 h after surgery, increased to full dose from the second dose and maintained for five days</p>
Outcomes	<ul style="list-style-type: none"> Thromboembolic complications: deep venous thrombosis with clinical diagnosis confirmed with Doppler ultrasound or vein angiography and pulmonary embolism
Notes	<p>The study included 18 participants with hip fracture: 7 in the intervention group and 11 in the control group</p> <p>Letter sent to study authors 8 June 2016; no reply received</p> <p>DOI 10.3969/j.issn.2095-4344.2015. 17.004</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomly divided by using a random number table"
Allocation concealment (selection bias)	Unclear risk	Not mentioned. It was not stated if the table was unavailable to recruiters
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants received a femoral catheter and intermittent pneumatic pressure or not
Blinding of outcome assessment (detection bias)	Unclear risk	Not mentioned

Chen 2015 (Continued)

All outcomes

Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	High risk	"There were no significant differences in gender, age, body mass, and other general characteristics" Thrombosis prophylaxis differed between groups

Cucereanu Badica 2010

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: Hospital of Bucharest, Bucharest, Romania Date of data collection: September 2009 to February 2010 Ethics committee: hospital ethical committee approval obtained Informed consent: informed consents obtained Funding: departmental resources
Participants	62 participants undergoing unilateral hip arthroplasty Follow-up until discharge, at least 5 days
Interventions	Intervention: fascia iliaca compartment block with 40 mL 0.5% ropivacaine (N = 14 without hip fracture) Control: no block (N = 15 without hip fracture) Spinal anaesthesia for surgery and IV morphine for postoperative analgesia for all participants
Outcomes	<ul style="list-style-type: none">• Pain at rest and on movement at 4, 8, 12, 24 and 48 h after surgery• Analgesic requirement: opioid consumption• Medical complications<ul style="list-style-type: none">* gastrointestinal: nausea and vomiting* cardiovascular: blood loss* neurological: acute confusional state. These data were not available for participants without hip fracture
Notes	Conference abstract Study authors provided data for participants without hip fracture
Risk of bias	
Bias	Authors' judgement Support for judgement

Cucereanu Badica 2010 (Continued)

Random sequence generation (selection bias)	High risk	Quasi-randomized, alternate allocation: "...one patient was allocated for group I, next patient for group II"
Allocation concealment (selection bias)	High risk	Alternate allocation
Blinding of participants and personnel (performance bias) All outcomes	Low risk	"The nurses and doctors (one senior and one resident from anaesthesia department and one senior from orthopedic department) involved in postoperative pain management and outcome assessment knows nothing about the allocation" "Were participants blinded to treatment group? Yes"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Were outcome assessors blinded to treatment allocation? Yes"
Incomplete outcome data (attrition bias) All outcomes	Low risk	"How many patients were lost to follow-up (randomised but not included in the analysis) in each treatment group and what were the reasons? I lost these data, as far as I remember there were 4-6 patients that received some AINS and antiemetic drugs (self-administration) during the first 48 hours, and 1-2 old patients that mentally deteriorated after surgery (we couldn't use any more Numeric Rating Scale)"
Selective reporting (reporting bias)	Low risk	Conference abstract, additional information provided by authors
Other bias	Low risk	Fewer male participants in the fascia iliaca block group (4 versus 8). Groups similar for age, ASA status and procedure duration

Duarte 2009

Methods	Parallel RCT Comparison: peripheral nerve blocks versus neuraxial block Site: Hospital Sarah, Brasília, Brazil Date of data collection: between March and September 2006 Ethics committee: approved by the Ethics and Research Committee of the Rede Sarah de Hospitais de Reabilitação Informed consent: written informed consents obtained Funding: unspecified
Participants	42 (ASA 1 to 3) adults scheduled for total hip replacement Exclusion criteria: refusal to participate; peripheral neuropathies, coagulopathies, or hypersensitivity to drugs used for analgesia; infection at the puncture site; spinal deformities or history of spinal surgery; scheduled for review of the hip
Interventions	Intervention: patient-controlled continuous posterior lumbar plexus block with 0.2% ropivacaine (N = 21) Control: patient-controlled continuous epidural lumbar block with 0.2% ropivacaine fentanyl 3 µg/mL (N = 20) General anaesthesia with alfentanil, propofol, nitrous oxide and sevoflurane for all participants

Duarte 2009 (Continued)

Additional IV morphine as rescue analgesia

Outcomes	<ul style="list-style-type: none"> Pain at rest and on movement at 0, 4, 8, 12, 24 and 48 h Analgesic requirement: opioid consumption Medical complications, gastrointestinal: nausea and vomiting Medical complications <ul style="list-style-type: none"> * cardiovascular: hypotension (> 30% decrease in systolic blood pressure), blood loss (intra-operatively and up to 48 h), units transfused * other: urinary retention Use of resources: length of hospital stay, discharge from functional therapy Short-term rehabilitation milestones: first mobilization (sitting), getting out of bed, first walk with the walker, perform daily activity, change walker for crutches
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Notes	Emailed study authors 11 June 2016; no reply received
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Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomly separated into two groups based on a computer-generated permutation table presented in sealed opaque envelopes... Randomized allocation was performed in eight-patient groups, stratified according to the surgical approach (lateral or posterior)"
Allocation concealment (selection bias)	Low risk	"...randomly separated into two groups based on a computer-generated permutation table presented in sealed opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	"The anaesthesiologist responsible for the case was informed of the group the patient belonged to only at the moment of the surgery and he did not have further participation in the study"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"The anaesthesiologist responsible for the case was informed of the group the patient belonged to only at the moment of the surgery and he did not have further participation in the study"
Incomplete outcome data (attrition bias) All outcomes	Low risk	One patient initially allocated in the lumbar group was excluded due to a change in conduct during the surgery, undergoing acetabuloplasty
Selective reporting (reporting bias)	High risk	"The incidence of adverse effects (nausea, vomiting, pruritus, urinary retention, and motor blockade of the lower limbs) was also analyzed". These results were not provided
Other bias	Unclear risk	Not included in intention-to-treat analysis. Participants included in both groups were similar regarding gender, age, weight, height, ASA physical status and comorbidities

Forget 2009

Methods	Parallel RCT Comparison: peripheral nerve block versus neuraxial block Site: Université Catholique de Louvain, Brussels, Belgium
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Forget 2009 (Continued)

	<p>Date of data collection: unspecified</p> <p>Ethics committee: Ethics committee approval obtained</p> <p>Informed consent: obtained</p> <p>Funding: departmental resources</p>
Participants	<p>20 participants aged from 20 to 80 years (weight between 50 kg and 100 kg) undergoing primary elective total hip arthroplasty</p> <p>Exclusion criteria: refusal to participate or contra-indication for any anaesthetic technique proposed</p>
Interventions	<p>Intervention: fascia iliaca block with 0.4 mL/kg 0.5% levobupivacaine (max 30 mL) plus clonidine 2.5 µg/mL and epinephrine 5 µg/mL (N = 10)</p> <p>Control: epidural analgesia with 10 mL 0.25% levobupivacaine and sufentanil 10 µg (N = 10)</p> <p>General anaesthesia for all participants</p> <p>Enoxparin 20 mg started at postoperative day 1</p>
Outcomes	<ul style="list-style-type: none"> • Pain up to 1 year after surgery • Analgesic requirement: opioid consumption • Medical complications, neurological: drowsiness • Use of resources: hospital length of stay • Participant satisfaction
Notes	<p>Additional information received from authors</p> <p>DOI 10.1007/s12630-008-9025-2</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Computer based randomisation"
Allocation concealment (selection bias)	Unclear risk	<p>"Allocation was kept secret by the principal investigator until the day of surgery"</p> <p>Unclear if the investigator recruiting was aware of the allocation before recruiting participants</p>
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	"Patients, surgeons, and ward nurses were blinded. Anaesthesiologists were not. The nurse devoted to pain management was blinded"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Were outcome assessors blinded to treatment group? Yes (nurse dedicated to pain management)"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results provided

Forget 2009 (Continued)

Other bias	Low risk	Groups well balanced
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Fouad 2010

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus neuraxial block</p> <p>Site: Nagoya University Hospital, Nagoya, Japan</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: unspecified</p> <p>Informed consent: unspecified</p> <p>Funding: unspecified</p>
Participants	32 participants undergoing elective total hip arthroplasty
Interventions	<p>Intervention: continuous psoas compartment block inserted under dual guidance (in-plane ultrasound guidance and nerve stimulator). Catheters loaded with 25 mL 0.375% ropivacaine followed by an infusion of 0.2% ropivacaine at 4 to 6 mL/h</p> <p>Control: continuous epidural analgesia, catheters loaded with 6 mL 0.5% ropivacaine and 100 µg of fentanyl followed by an infusion of 0.2% ropivacaine plus fentanyl 4 µg/mL at 4 to 6 mL/h</p> <p>All participants: general anaesthesia for surgery and IV flurbiprofen for postoperative analgesia</p>
Outcomes	<ul style="list-style-type: none"> Pain at rest and on movement (physiotherapy) 4, 8, 16, 24, 48 and 72 h for all participants: epidural analgesia significantly reduced pain scores at 4, 8, 16, and 24 and 72 h at rest and at 16 h during physiotherapy compared with psoas compartment blocks Analgesic requirement: opioid consumption: there were no significant differences for pentazocine consumption, opioid-related side effects, complications between the analgesic techniques Participant satisfaction: there were no significant differences for participant satisfaction between the analgesic techniques
Notes	<p>Conference abstract: numbers not provided, one figure with mean values without error bars</p> <p>Email sent to study authors 11 June 2016; no reply received</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...were randomized", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not mentioned
Blinding of outcome assessment (detection bias)	Unclear risk	Not mentioned

Nerve blocks or no nerve blocks for pain control after elective hip replacement (arthroplasty) surgery in adults (Review)

Fouad 2010 (Continued)

All outcomes

Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Unclear risk	Numbers not given (conference abstract)
Other bias	Low risk	"Demographic data were similar in both groups"

Fournier 1998

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: University Hospital of Geneva, Switzerland Date of data collection: unspecified Ethics committee: institutional approval obtained Informed consent: informed consents obtained Funding: unspecified
Participants	40 (ASA 1 to 3) participants scheduled for total hip replacement under general anaesthesia
Interventions	Intervention: 3-in-1 femoral nerve block (nerve stimulation) with 40 mL 0.5% bupivacaine with epinephrine (N = 20) Control: sham block (N = 20) All participants: general anaesthesia with midazolam, thiopental, fentanyl, nitrous oxide, isoflurane and vecuronium
Outcomes	<ul style="list-style-type: none"> Pain at 24 and 48 h Analgesic requirement: time to first request of an analgesic, opioid consumption, other analgesic consumption
Notes	Email sent to study authors 11 June 2016; no reply received DOI 10.1007/BF03011989

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomly assigned", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias)	Low risk	"...a second anaesthetist not in charge of the patient, and in the absence of the anaesthetist responsible of the investigation, performed a simple needle puncture at the site of the femoral nerve in the patients of group gener-

Nerve blocks or no nerve blocks for pain control after elective hip replacement (arthroplasty) surgery in adults (Review)

Fournier 1998 (Continued)

All outcomes		al anaesthesia and a femoral nerve block following Winnie's landmarks in patients of group general anaesthesia plus femoral nerve block"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"...a second anaesthetist not in charge of the patient, and in the absence of the anaesthetist responsible of the investigation, performed a simple needle puncture at the site of the femoral nerve in the patients of group general anaesthesia and a femoral nerve block following Winnie's landmarks in patients of group general anaesthesia plus femoral nerve block"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	Measurements mentioned in the methods section were reported in results section
Other bias	Low risk	Groups similar for demographic data

Frassanito 2008

Methods	Parallel RCT Comparison: peripheral nerve block versus neuraxial block Site: Gemelli Hospital, Rome, Italy Date of data collection: unspecified Ethics committee: local Ethical Committee approved the protocol Informed consent: informed consents obtained Funding: unspecified
Participants	40 (ASA 1 to 3) participants scheduled for primary unilateral hip arthroplasty Exclusion criteria: renal dysfunction, allergy to opioids, local anaesthetics, NSAIDs and paracetamol, pre-operative respiratory insufficiency, coagulopathy, and/or treatment with anticoagulants or aspirin
Interventions	Intervention: psoas compartment block with ropivacaine 0.5% 0.4 mL /kg (N = 20) Control: intrathecal administration 15 mg hyperbaric bupivacaine, 0.1 mg morphine and 0.015 mg fentanyl (N = 20) All participants: general anaesthesia with fentanyl, propofol nitrous oxide, sevoflurane and vecuronium
Outcomes	<ul style="list-style-type: none"> • Pain at 4, 12, 24 and at 36 h • Analgesic requirement: tramadol consumption (taken as opioids) • Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting * cardiovascular: hypotension (requiring unusual amounts of IV ephedrine and/or fluids) * others: respiratory depression (rate < 10 breaths per minute), urinary retention, pruritus • Participant satisfaction
Notes	Email sent to study authors 23 June 2016; no reply received

Risk of bias

Frassanito 2008 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomized", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	"...single blinded... The procedures were performed by a senior anaesthetist, highly trained in both techniques and not involved in the postoperative evaluation of the patients... supervised in post-anaesthesia care unit by an anaesthesiologist blinded to group assignment"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"...single blinded... The procedures were performed by a senior anaesthesiologist, highly trained in both techniques and not involved in the postoperative evaluation of the patients"
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Dural puncture was successful in all patients in Group I and femoral block was effective in all patients in Group II... How many patients were lost to follow-up (randomised but not included in the analysis) in each treatment group and what were the reasons? I lost these data, as far as I remember there were 4-6 participants that received some non steroid antiinflammatory drugs and antiemetic drugs (self-administration) during the first 48 hours, and 1-2 old participants that mentally deteriorated after surgery (we couldn't use any more Numeric Rating Scale)"
Selective reporting (reporting bias)	Low risk	No error bars in the figure
Other bias	Low risk	"There was no statistically significant difference in age, height, weight, gender and intraoperative fentanyl requirements"

Fredrickson 2015

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus neuraxial block</p> <p>Site: Auckland Southern Cross Hospital Group, Auckland, New Zealand</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: local institutional review board approval was obtained (Northern Y Regional Ethics Committee, Hamilton, New Zealand; approval number NTY/09/03/029)</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: charity: Grant from the Auckland Medical Research Foundation</p>
Participants	<p>50 (ASA 1 to 3) participants undergoing total elective hip joint replacement</p> <p>Exclusion criteria: spinal or lumbar plexus block refusal, spinal deformities likely to render subarachnoid block technically difficult, known amide local anaesthetic drug allergy, known neuropathy of the operative extremity, NSAID intolerance, and preoperative opioid therapy administered > 1 month before surgery</p>
Interventions	Intervention: patient-controlled continuous psoas compartment blockade (N = 27)

Fredrickson 2015 (Continued)

Control: intrathecal morphine 0.1 mg with 10 mg bupivacaine (N = 23)

All participants: general anaesthesia and IV parecoxib intra-operatively and diclofenac plus paracetamol regularly

Outcomes	<ul style="list-style-type: none"> • Pain at rest and on movement at 0, 24 and 48 h • Analgesic requirement: opioid consumption • Medical complications <ul style="list-style-type: none"> * gastrointestinal, nausea and vomiting requiring treatment * neurological: acute confusional state, transient signs of neurological irritation or injury * others: respiratory depression (pulse oximetry), pruritus, fall • Quality of life, other: sleeping • Short-term rehabilitation milestones: time to start rehabilitation (transfer unassisted from bed to chair), time to achieve rehabilitation milestones (perform 12 meters walk and time to achieve that walk) • Participant satisfaction
Notes	<p>Australian New Zealand Clinical Trials Registry (ACTRN12609000316202, March 2009)</p> <p>Emailed study authors 23 June 2016; no reply received</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomisation to the two groups was implemented by the research assistant away from the study procedures using a computer-generated random number delivered to the study site in pre-prepared sealed opaque envelopes"
Allocation concealment (selection bias)	Low risk	"Randomisation to the two groups was implemented by the research assistant away from the study procedures using a computer-generated random number delivered to the study site in pre-prepared sealed opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	No sham block
Blinding of outcome assessment (detection bias) All outcomes	High risk	"The main limitation of the present study is the lack of observer blinding"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results mentioned in the Method section reported in Results section
Other bias	Low risk	Groups comparable for sex distribution, age and weight

Gelmanas 2010

Methods	Parallel RCT
	Comparison: peripheral nerve block versus neuraxial block

Gelmanas 2010 (Continued)

Site: Kaunas Medical University Hospital, Kaunas, Lithuania

Date of data collection: unspecified

Ethics committee: approval from the local human ethics committee obtained

Informed consent: not mentioned

Funding: unspecified

Participants	34 (ASA 1 or 2) participants undergoing primary hip replacement surgery
Interventions	<p>Intervention: continuous psoas compartment block with 0.125% bupivacaine and fentanyl 5 µg/mL at 5 to 10 mL/h (exact number not given; taken as N = 17)</p> <p>Control: continuous epidural analgesia with 0.125% bupivacaine and fentanyl 5 µg/mL at 3 to 5 mL/h (exact number not given; taken as N = 17)</p>
Outcomes	<ul style="list-style-type: none"> Pain at 6, 24 and 48 h after surgery Analgesic requirement: number of participants requiring additional analgesia Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting * others: pruritus
Notes	<p>Conference abstract</p> <p>Emailed study authors 23 June 2016; no reply received</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomised", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Low risk	"...double-blind", no further details
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"...double-blind", no further details
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up mentioned
Selective reporting (reporting bias)	Unclear risk	Limited information, conference abstract
Other bias	Low risk	"There was no significant difference in patient demographics"

Ginz 2000

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: Baden, Kliniken des Landkreises Lörrach, Germany</p> <p>Date of data collection: 1998</p> <p>Ethics committee: approval from the local human ethics committee obtained</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: departmental resources</p>
Participants	<p>40 (ASA 1 to 3) participants undergoing total hip replacement for arthrosis (N = 36) or correction of fractured neck femur (N = 22)</p> <p>Exclusion criteria: allergy to local anaesthetics, uncontrolled hypertension, bradycardia or other rhythm anomalies, pre-existing neurological disease in the operated area, infection at the puncture site and coagulation disorders</p> <p>Follow-up: 48 h</p>
Interventions	<p>Intervention: obturator nerve block (N = 18)</p> <p>Control: no block (N = 18)</p> <p>General anaesthesia and postoperative analgesia with diclofenac or metamizole and piritramid as required for all participants</p>
Outcomes	<ul style="list-style-type: none"> Analgesic requirements
Notes	Additional information received from authors

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomized by lot"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	"...investigator was not blinded" and no sham block
Blinding of outcome assessment (detection bias) All outcomes	High risk	"...investigator was not blinded"
Incomplete outcome data (attrition bias) All outcomes	Low risk	<p>"Patients with unsuccessful blocks were excluded from the study"</p> <p>"Two patients were excluded because of impossibility to perform the block or changed of procedure" (from the report)</p> <p>"4 patients dropped out from the study" (from authors)</p>

Ginz 2000 (Continued)

Selective reporting (reporting bias)	Low risk	Results mentioned in the method section were reported in the results section or provided by authors
Other bias	Unclear risk	Not included in intention-to-treat analysis

Goytizolo 2016

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block added to neuraxial block versus systemic neuraxial block alone</p> <p>Site: Hospital for Special Surgery, New York, NY, USA</p> <p>Date of data collection: enrolment for primary outcome was completed 14 January 2011</p> <p>Ethics committee: approval from the Institutional Review Board of Hospital for Special Surgery (IRB #28098)</p> <p>Informed consent: written, informed consents obtained</p> <p>Funding: charity "This study was supported with funds from the Research and Education Fund of the Department of Anesthesiology at the Hospital for Special Surgery. Dr. Sandra Hurtado Rúa was partially supported by the following grant: Clinical Translational Science Center (CTSC) (UL1- RR024996)"</p>	
Participants	<p>92 (ASA 1 to 3) participants aged between 60 and 100 years undergoing total hip replacement</p> <p>Exclusion criteria: refusal to participate, not within institutional review board-approved age range, surgery other than primary total hip replacement, chronic opioid use (defined as daily use of opioids for > 3 months), allergy to study medications, and contra-indication to combined spinal epidural anaesthesia or lumbar plexus block (history of lumbar spinal fusion, bleeding disorder, use of clinically relevant anticoagulant or antiplatelet medications, anatomic abnormalities, infection at a potential injection site)</p>	
Interventions	<p>Intervention: single injection lumbar plexus block (N = 46)</p> <p>Control: no block (N = 44)</p> <p>Combined spinal/epidural for the surgery, ondansetron for nausea and vomiting prophylaxis and epidural analgesia for 24 h for postoperative analgesia</p>	
Outcomes	<ul style="list-style-type: none"> Pain at rest at 0, 24 and 48 h Analgesic requirement: opioid requirement Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting (risk and number of participants requiring treatment) * cardiovascular: blood loss, risk of receiving more than one transfusion after surgery 	
Notes	<p>Full text received from authors following request</p> <p>DOI 10.1007/s11420-015-9477-1</p>	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomised... Excel-based randomizing software, all treatment assignments were prepared prior to study commencement by unaffiliated research personnel"

Goytizolo 2016 (Continued)

Allocation concealment (selection bias)	Low risk	"Randomised treatments were placed in sealed opaque envelopes and were opened only after the treating anaesthesiologist obtained written informed consent from the patient"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	"...double-blinded... Study patients and data assessors remained blinded throughout the patients' participation... For blinding purposes, control patients were prepared as if they were receiving LPB, and a bandage was placed on the patients' backs in the appropriate site for lumbar plexus bloc" Anaesthesiologists caring for participants performed the blocks
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"...double-blinded... Study patients and data assessors remained blinded throughout the patients' participation... A blinded research assistant recorded three measurements at each time point of interest"
Incomplete outcome data (attrition bias) All outcomes	Low risk	"2 patients were excluded due to equipment failure shortly after enrolment"
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	"Patient demographics were similar in both groups"

Green 2014

Methods	Parallel RCT Comparison: peripheral nerve block (surgeon administered) versus systemic analgesia Site: Midwestern Regional and Croom Orthopaedic Hospital, Limerick, Ireland Date of data collection: unspecified Ethics committee: Institutional ethical committee approval obtained Informed consent: Written informed consents obtained Funding: departmental resources only
Participants	53 participants undergoing primary total hip replacement Exclusion criteria was an allergy to local anaesthetics
Interventions	Intervention: surgeon administered intra-operative psoas compartment block with 40 mL 0.25% bupivacaine and 10 mL saline (N = 26) Control: no block (N = 27) All participants: spinal anaesthesia for the surgery, regular paracetamol, diclofenac and oxycontin for postoperative analgesia
Outcomes	<ul style="list-style-type: none"> Pain at 2, 4, 6, 8, 10, 12, 16, 20 and 24 h after surgery Analgesic requirement: time to first request of an analgesic, additional opioid consumption Short-term rehabilitation milestones: first day mobility

Green 2014 (Continued)

Notes Emailed study authors 26 June 2016; no reply received
DOI [org/10.1016/j.arth.2013.06.028](https://doi.org/10.1016/j.arth.2013.06.028)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...random number allocation"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	"The surgeon, the anaesthetist and the recovery room nursing staff were not blinded in the study..." However, the patient and the ward nurses recording postoperative pain scores were blinded"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"However, the patient and the ward nurses recording postoperative pain scores were blinded"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Low risk	"There was no difference between the demographics of the groups when compared for age, sex, side of surgery, diagnosis and ASA grade"

Jensen 2012

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: Copenhagen, Denmark</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: not mentioned</p> <p>Informed consent: not mentioned</p> <p>Funding: unspecified</p>
Participants	28 participants undergoing primary total hip arthroplasty
Interventions	<p>Intervention: femoral, obturator (anterior branch) and lateral femoral cutaneous nerve blocks (N = 19)</p> <p>Control: placebo blocks (N = 9)</p>
Outcomes	<ul style="list-style-type: none"> Pain scores at rest and on movement at 5, 10, 15, 20, 25, 30, 35, 40 and 45 h Medical complications: gastrointestinal: nausea, vomiting, excessive sedation

Nerve blocks or no nerve blocks for pain control after elective hip replacement (arthroplasty) surgery in adults (Review)

Jensen 2012 (Continued)

- Short-term rehabilitation milestones: time to first mobilization, Barthel physical function, SF-8

Notes	3 conference abstracts
	Preliminary results on 28 participants, 81 scheduled
	Email sent to study authors 26 June 2016; no reply received
	NCT01276925

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomised", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Low risk	"...placebo blocks"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"...placebo blocks"
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Partial results (28/81 scheduled)
Selective reporting (reporting bias)	Unclear risk	Partial results (28/81 scheduled)
Other bias	Unclear risk	Limited information (conference abstract)

Kai 2010

Methods	Parallel RCT
	Comparison: peripheral nerve block versus neuraxial block
	Site: Xijing Hospital of the Fourth Military Medical University, China
	Date of data collection: from June 2006 to June 2010
	Ethics committee: not mentioned in the translation
	Informed consent: not mentioned in the translation
	Funding: supported by the National Natural Science Foundation of China. NO.30772074
Participants	46 (ASA 2 or 3) participants aged from 67 to 86 years scheduled total hip replacement because of traumatic femoral neck fracture or femoral head necrosis
Interventions	Intervention: psoas compartment block (N = 23)

Kai 2010 (Continued)

Control: epidural analgesia (N = 23)

Spinal anaesthesia (isobaric) for the surgery for all participants

Outcomes	<ul style="list-style-type: none"> Analgesic requirement: time to first analgesic request (duration of analgesia), opioids consumption Medical complications <ul style="list-style-type: none"> * cardiovascular: hypotension (intra-operative blood pressure decrease > 25% thus requiring treatment) * others: respiratory depression based on SaO₂
Notes	<p>Email sent to study authors 26 June 2016; no reply received</p> <p>We retained the trial in the review but data could not be meta-analysed. Separate data were not available for participants without hip fracture</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomly divided", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not mentioned
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Unclear risk	Limited information on groups' characteristics

Kearns 2011

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus neuraxial block</p> <p>Site: University of Glasgow, Glasgow, UK</p> <p>Date of data collection: from 23 May 2011 to 7 April 2014</p> <p>Ethics committee: West of Scotland Research Ethics Committee 4 (reference no. 10/S0704/43)</p> <p>Informed consent: written informed consents obtained</p>
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Kearns 2011 (Continued)

Funding: Governmental and charity

Participants	<p>108 (ASA 1 to 3) participants aged between 18 and 85 years scheduled to undergo unilateral primary total hip arthroplasty</p> <p>Exclusion criteria: contra-indications to fascia iliaca plane block or spinal anaesthesia such as coagulopathy, malignancy or infection in the inguinal area, preference for general anaesthesia, allergy to opioids, significant peripheral neuropathy or neurological disorder affecting the lower extremity, pregnancy, history of alcohol or drug dependency, history of long term strong opioid intake (i.e. WHO step 3 analgesics), and history of significant psychiatric conditions that may affect patient assessment</p>
Interventions	<p>Intervention: ultrasound-guided fascia iliaca block with levobupivacaine (N = 54)</p> <p>Control: intrathecal morphine 0.1. mg and sham block (N = 54)</p> <p>All participants: spinal anaesthesia for the surgery and regular paracetamol plus patient-controlled IV analgesia with morphine for postoperative analgesia</p>
Outcomes	<ul style="list-style-type: none"> • Pain scores at rest and on movement at 3, 6, 12, 24 and 48 h • Analgesic requirement: opioid consumption at 24 h • Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting (requiring treatment) * cardiovascular: hypotension (systolic arterial blood pressure < 80 mmHg), blood loss * neurological, sedation requiring treatment * others: respiratory depression, pruritus (requiring treatment), urinary retention • Short-term rehabilitation milestones: time to first mobilization • Participant satisfaction
Notes	<p>ClinicalTrials.gov NCT01217294.</p> <p>Study authors provided additional information</p> <p>Follow-up of 48 h plus chart review at 3 months for adverse events or re-hospitalization</p> <p>DOI 10.1111/anae.13620</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"A computer generated allocation sequence (in permuted blocks) will be created by an independent operator who is not directly involved with the study"
Allocation concealment (selection bias)	Low risk	"Once created, the allocation sequence will be kept in a secure locked drawer making it inaccessible to all study personnel. Allocation concealment will be achieved using sequentially numbered sealed envelopes which are opaque when held to the light. When a patient is enrolled in the study, an administrator working within the Glasgow University Academic Unit of Anaesthesia will be contacted and asked to give the next numbered envelope to the anaesthetist who will make up the medications used in the study"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	"The ultrasound guided fascia iliaca block was performed by an anaesthetist deemed competent in this technique. The Injectate solutions were pre-prepared in an aseptic manner by a separate anaesthetist not involved with post-operative data collection or analysis. In this way, the investigator performing the ultrasound guided fascia iliaca block and spinal injections was blinded to the nature of the Injectate. As patients received both spinal and ultrasound guided fascia iliaca injections, they were also blinded. Data were anonymised and collected by an investigator blinded to the patient's allocation"

Kearns 2011 (Continued)

		"The anaesthetist was the only person who was aware of the group allocation"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Data were anonymised and collected by an investigator blinded to the patient's allocation"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No participants were lost to follow up. The following participants were not included in the as-treated analysis: Fascia iliaca group – 2 participants discontinued the intervention due to their requirement for general anaesthesia. Therefore, 54 participants were analysed in the intention-to-treat analysis and 52 in the as-treated analysis Spinal morphine group – 2 participants did not receive the intervention due to surgical cancellation (1 participant had previously undiagnosed cellulitis and the other was cancelled due to lack of time on the operating list). One participant discontinued the intervention because general anaesthetic was required. Therefore, 54 participants were analysed in the intention-to-treat analysis and 51 in the as-treated analysis
Selective reporting (reporting bias)	Low risk	All results mentioned in the methods section were provided in the results section
Other bias	Low risk	"Patient demographics were similar between groups" "The study will be performed using both intention to treat and 'as treated' analyses"

Kendrisic 2013

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: Sremska Mitrovica, Serbia Date of data collection: unspecified Ethics committee: approval of the local ethics committee obtained Informed consent: not mentioned Funding: unspecified
Participants	62 (ASA 2 or 3) participants undergoing hip replacement surgery
Interventions	Intervention: continuous psoas compartment block loaded with 20 mL 0.25% levobupivacaine followed by an infusion of the same solution at 7 ± 1.8 mL/h (N = 32) Control: IV patient-controlled analgesia with morphine (N = 30) All participants; general anaesthesia with fentanyl, propofol, nitrous oxide, sevoflurane and rocuronium
Outcomes	<ul style="list-style-type: none"> Pain scores at rest and on movement at 0, 4, 12 and 24 h
Notes	Conference abstract Letter sent to study authors 26 June 2016: no reply received

Risk of bias

Kendrisic 2013 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomised", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	No sham block
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Unclear risk	Limited information
Other bias	Unclear risk	Limited information

Kratz 2015

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: University Hospital, Philipps-University of Marburg, Baldinger Strasse, D-35033 Marburg, Germany</p> <p>Date of data collection: May 2009 to May 2010</p> <p>Ethics committee: Ethics Committee approval (University Hospital of Marburg)</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: departmental resources only</p>
Participants	<p>80 participants who underwent elective hip surgery (hip arthroplasty in the discussion section, first sentence)</p> <p>Exclusion criteria: surgery involving change of endoprostheses, aged < 40 years, ASA classification > 2, expected intra-operative blood loss > 1000 mL and clinically significant renal, cardiac or respiratory impairment</p>
Interventions	<p>Intervention: single injection femoral block (N = 26)</p> <p>Control: no block (N = 26)</p> <p>All participants: general anaesthesia with fentanyl, propofol, sevoflurane and rocuronium for the surgery, routine anti-emetic prophylaxis with 4 mg dexamethasone and 25 mg dolasetron and metamizole, ibuprofen, IV piritramide and oral oxycodone for postoperative analgesia</p>
Outcomes	<ul style="list-style-type: none"> Pain scores at 0, 0.5, 2, 6 and 24 h after surgery

Kratz 2015 (Continued)

- Analgesic requirements: opioids and non steroid antiinflammatory drugs requirements
- Medical complications, cardiovascular: blood loss

Notes

Registration at German Clinical Trial Register (DRKS-ID): DRKS00000752

Emailed study authors 27 June 2016: no reply received

DOI 10.3233/THC-150898

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...closed envelope randomization"
Allocation concealment (selection bias)	Low risk	"...closed envelope randomization"
Blinding of participants and personnel (performance bias) All outcomes	High risk	"The study was randomized, but not blinded... nerve block was accomplished by some very experienced study anaesthetists, to which the attending anaesthesiologist was not blinded"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Surgical dressing of the hip and inguinal region on the operation site in all patients ensured adequate blinding of nurses and research staff in PACU and on the wards. Furthermore, nursing, and analgesic treatment was performed by regular PACU staff without intervention by the research team"
Incomplete outcome data (attrition bias) All outcomes	High risk	52 participants were included for statistical analysis; 28 participants (14 in each group) were eliminated due to protocol violation
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Unclear risk	Not in included intention-to-treat analysis Demographic data and pre-operative measurements did not differ significantly between groups Pre-operative pain scores were higher (although not statistically significantly so) in the femoral nerve block group (4.2 ± 2.9 versus 2.9 ± 3.1)

Köroğlu 2008

Methods

Parallel RCT

Comparison: peripheral nerve block versus systemic analgesia

Site: Training and Research Hospital, Ministry of Health, Ankara, Turkey

Date of data collection: unspecified

Ethics committee: approved by the ethics committee

Informed consent: written informed consents obtained

Köroğlu 2008 (Continued)

Funding: unspecified

Participants	<p>30 (ASA 1 or 2) participants undergoing elective total hip arthroplasty</p> <p>Exclusion criteria: aged < 20 years or > 85 years, weight < 50 kg or > 110 kg, history of allergy to local anaesthetics, peripheral neuropathy, neurological deficit, abnormal coagulation profile, mental retardation or dementia and those who could not adequately understand pain scoring systems and use of patient-controlled analgesia device</p>
Interventions	<p>Intervention: femoral (3-in-1) block with nerve stimulator using 40 mL of bupivacaine 0.25% (N = 15)</p> <p>Control: sham block (N = 15)</p> <p>All participants: general anaesthesia with fentanyl, thiopental, nitrous oxide, sevoflurane and atracurium for the surgery and patient-controlled analgesia with tramadol plus meperidine as rescue analgesia for postoperative analgesia</p>
Outcomes	<ul style="list-style-type: none"> Pain scores at rest and on movement (passive movement) at 0, 0.5, 1, 4, 8, 12, 24 and 48 h after surgery Analgesic requirement: opioid (tramadol and pethidine) consumption Medical complications <ul style="list-style-type: none"> * cardiovascular: hypotension (decrease > 30% in mean arterial blood pressure) * gastrointestinal: nausea and vomiting * neurological: sedation (ascending scale from 0 to 4) * others: respiratory depression (rate < 8 breaths per minute), pruritus Participant satisfaction
Notes	Emailed study authors 27 June 2016; no reply received

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomised... using computer-generated random numbers"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Sham block
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Sham block "...intraoperative and postoperative assessment was performed by an investigator blinded to the patient's group"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	Error bars not provided
Other bias	Low risk	"There was no difference between the groups as to gender, age, height, weight, ASA, anaesthesia duration and operation duration"

Lončar 2016

Methods	<p>Parallel RCT?</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: Belgrade, Serbia and Medical Faculty, University of East Sarajevo, Foča, Republic of Srpska- Bosnia and Herzegovina, Clinical Pharmacology, Foca, Bosnia and Herzegovina</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: unspecified</p> <p>Informed consent: unspecified</p> <p>Funding: unspecified</p>
Participants	30 participants scheduled for elective hip arthroplasty
Interventions	<p>Intervention: single injection femoral nerve block (N = exact number of participants unspecified, taken as 10) or single fascia iliaca compartment block (N = exact number of participants unspecified, taken as 10)</p> <p>Control: morphine 5 mg or 10 mg IV every 6 h, depending on bodyweight, paracetamol 1 g IV every 6 h (N = exact number of participants unspecified, taken as 10)</p>
Outcomes	<ul style="list-style-type: none"> Pain scores at 1 h after surgery (taken as at rest) Analgesic requirements: opioids
Notes	Conference abstract, no corresponding address available

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...comparative study"
Allocation concealment (selection bias)	Unclear risk	Unspecified
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unspecified
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unspecified
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up reported
Selective reporting (reporting bias)	Low risk	Measurements made in the method section are reported in the results section
Other bias	Unclear risk	Conference abstract, limited information

Marino 2009

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: Huntington Hospital, Huntington, NY, USA</p> <p>Date of data collection: May 2003 to November 2005</p> <p>Ethics committee: Institutional Review Board approval obtained</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: departmental resources only</p>
Participants	<p>225 (ASA 1 to 3 participants) aged 18 to 80 years with primary diagnosis of osteoarthritis undergoing unilateral primary total hip arthroplasty through the posterolateral approach</p> <p>Exclusion criteria: allergy to local anaesthetics, peripheral neuropathy, proven opioid dependency, laboratory evidence of coagulopathy (international normalized ratio > 1.4), platelet count < 100,000, and dementia as assessed by evidence of memory loss indicated by a lack of orientation to person, place and time</p>
Interventions	<p>Intervention 1: continuous psoas compartment block for 48 h (N = 75)</p> <p>Intervention 2: continuous femoral nerve block for 48 h (N = 75)</p> <p>Control: no block (N = 75)</p> <p>Blocks performed after surgery under spinal anaesthesia</p> <p>All participants: IV patient-controlled analgesia with hydromorphone and IM ketorolac for postoperative analgesia for 48 h, antiemetic prophylaxis with metoclopramide and famotidine</p>
Outcomes	<ul style="list-style-type: none"> Pain scores at rest and on movement (physical therapy) at, 2, 24 and 48 h Analgesic requirement: opioids Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting (requiring treatment) * neurological: acute confusional state (complete loss of orientation to time and space), drowsiness * others: respiratory depression, pruritus Short-term rehabilitation milestones: hip flexion, ability to walk > 12.2 m Participant satisfaction
Notes	<p>Registered with ClinicalTrials.gov (NCT00790179)</p> <p>Emailed authors 27 June 2016; no reply received</p> <p>DOI 10.2106/JBJS.H.00079</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"On the morning of surgery, the patients were randomly allocated by the primary investigator, according to a computer generated randomization schedule that was arranged in permuted blocks of three"
Allocation concealment (selection bias)	Unclear risk	Not mentioned

Marino 2009 (Continued)

Blinding of participants and personnel (performance bias) All outcomes	High risk	No sham block
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Low risk	Demographic data, duration of surgery, and duration of hospitalization were similar in all three groups

Marshall 2008

Methods	Parallel RCT Comparison: peripheral nerve block versus neuraxial block Site: Royal Cornwall Hospital, Anaesthesia Department, Truro, UK and Sir Charles Gairdner Hospital, Department of Anaesthesia and Pain Management, Perth, Western Australia Date of data collection: unspecified Ethics committee: approved by the ethics committee Informed consent: unspecified Funding: unspecified	
Participants	52 participants scheduled for primary, unilateral total hip arthroplasty	
Interventions	Intervention: continuous psoas compartment block plus IV patient-controlled analgesia with morphine (N = 29) Control: epidural analgesia (N = 23) All participants: spinal anaesthesia for the surgery	
Outcomes	<ul style="list-style-type: none">• Pain scores at 6, 24, 36 and 48 h• Analgesic requirement: opioids consumption	
Notes	Conference abstract Letter sent to study authors 27 June 2016; no reply received	
Risk of bias		
Bias	Authors' judgement	Support for judgement

Marshall 2008 (Continued)

Random sequence generation (selection bias)	Low risk	"...randomised by barrel draw"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants received an epidural or a lumbar plexus infusion
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up mentioned
Selective reporting (reporting bias)	Unclear risk	Limited information
Other bias	High risk	Limited information IV patient-controlled analgesia provided to one group only

Murray 2005

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: Musgrave Park Hospital, Belfast, Northern Ireland, UK Date of data collection: unspecified Ethics committee: not mentioned Informed consent: written informed consents obtained Funding: unspecified
Participants	50 (ASA 1 to 3) participants undergoing primary hip arthroplasty
Interventions	Intervention: single injection fascia iliaca block (N = 25) Control: no block (N = 25) All participants: spinal anaesthesia for surgery and patient-controlled analgesia for postoperative analgesia
Outcomes	<ul style="list-style-type: none"> Analgesic requirement: opioid consumption at 5,10, 15 and 24 h
Notes	Conference abstract Emailed study authors 29 June 2016; no reply received

Risk of bias

Murray 2005 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomly allocated", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	No sham block
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up mentioned
Selective reporting (reporting bias)	Low risk	All outcomes proposed in the methods section were reported in the results section
Other bias	Unclear risk	Limited information (conference abstract)

Nicholson 2002

Methods	<p>Parallel RCT</p> <p>Comparison:</p> <p>Site: St George's Hospital Medical School, London, UK</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: Local Research Ethics Committee approval (97.42.14)</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: unspecified</p>
Participants	<p>36 female participants aged over 55 years undergoing elective total hip replacement</p> <p>Exclusion criteria: diseases or metabolic disorders known to alter bone metabolism taking drugs known to affect bone metabolism; malignancies with bony metastases; kidney failure; chronic liver disease; diabetes mellitus; rheumatoid arthritis; taking corticosteroids or anticonvulsants</p>
Interventions	<p>Intervention: single injection femoral (3-in-1) block (N = 12)</p> <p>Control 1: no block and propofol (N = 12)</p> <p>Control 2: no block and etomidate (N = 12)</p> <p>All participants: general anaesthesia with fentanyl, propofol or etomidate, nitrous oxide, isoflurane and vecuronium for surgery and IM morphine, paracetamol and oral non steroidal analgesics for postoperative analgesia for 72 h</p>

Nicholson 2002 (Continued)

Outcomes	• Medical complications, cardiovascular: number of units transfused (if measured blood loss > 1 L)	
Notes	Emailed study authors 29 June 2016: no reply received	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...allocated using random number tables"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Blocks were performed under general anaesthesia; therefore, participants could have been blinded to the treatment group
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	"The groups were similar in terms of age, weight, duration of surgery, pre-operative haemoglobin concentration... Eighty-eight percent of patients were taking non-steroidal anti-inflammatory medication on admission to hospital (11 in the propofol group, 11 in the propofol/regional analgesia group and 10 in the etomidate group)"

Nishio 2014

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: Hyogo College of Medicine, Nishinomiya City, Hyogo, Japan Date of data collection: unspecified Ethics committee: Institutional Review Board approval was obtained Informed consent: written informed consents obtained Funding: unspecified
Participants	40 participants who underwent primary unilateral total hip arthroplasty Exclusion criteria: neurological or psychological problems potentially posing difficulty in pain assessment
Interventions	Intervention: continuous femoral block (N = 10)

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Nishio 2014 (Continued)

Control 1: systemic opioid-based regimen: IV patient-controlled analgesia with fentanyl (N = 9)

Control 2: systemic non opioid-based regimen: rectal or IV NSAIDs on request (N = 9)

All participants: general anaesthesia

Outcomes	<ul style="list-style-type: none"> • Pain scores at 0, 6 and 12 hours after surgery • Analgesic requirement: rescue analgesia • Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting (requiring treatment) * cardiovascular: blood loss * neurological: drowsiness • Short-term rehabilitation milestones "delay in functional recovery in the early postoperative period (within 14 days after surgery)"
Notes	<p>The study also contained another group who received continuous caudal analgesia. Data were not retained for meta-analysis</p> <p>Emailed study authors 29 June 2016; no reply received</p> <p>DOI 10.4081/or.2014.5138</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"40 consecutive patients who met the above mentioned criteria were included in the study and randomly divided into 4 groups using the closed envelope method"
Allocation concealment (selection bias)	Low risk	"40 consecutive patients who met the above mentioned criteria were included in the study and randomly divided into 4 groups using the closed envelope method"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants received femoral, epidural or no catheter
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	"During the course of the analysis of the study results, 4 patients who underwent revision THA were excluded from the study to make a comparison for subjects with more standardized characteristics. Consequently, the remaining 36 patients constituted the base of this study"
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Low risk	"The patient characteristics such as age at surgery, body weight, and height were comparable among the groups with no significant intergroup difference"

Nohel 2011

Methods	Parallel RCT
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Nerve blocks or no nerve blocks for pain control after elective hip replacement (arthroplasty) surgery in adults (Review)

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Nohel 2011 (Continued)

Comparison: peripheral nerve block versus systemic analgesia

Site: Hospital Son Llàtzer, Palma de Mallorca, Spain

Date of data collection: unspecified

Ethics committee: not mentioned

Informed consent: not mentioned

Funding: unspecified

Participants	60 participants scheduled for total hip arthroplasty
Interventions	<p>Intervention: patient-controlled femoral nerve block (exact number in each group not given, taken as N = 30)</p> <p>Control: IV patient-controlled analgesia with morphine (exact number in each group not given, taken as N = 30)</p>
Outcomes	<ul style="list-style-type: none"> Pain at rest and on movement at 24 and 48 h after surgery Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting * neurological: drowsiness Participant satisfaction
Notes	<p>Conference abstract</p> <p>Emailed study authors 1 July 2016; no reply received</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomised", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	No sham block
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not mentioned
Selective reporting (reporting bias)	Unclear risk	Limited information, standard errors not provided
Other bias	Unclear risk	Limited information

Saksena Shrivastava 2011

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: India</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: not mentioned</p> <p>Informed consent: not mentioned</p> <p>Funding: unspecified</p>
Participants	75 participants scheduled for total hip replacement
Interventions	<p>Intervention: continuous femoral nerve block with 0.1 mL/kg/h 0.1% bupivacaine (exact number in each group unclear, taken as N = 25)</p> <p>Control: no block (exact number in each group unclear, taken as N = 25)</p> <p>All participants: IV patient-controlled analgesia with fentanyl</p>
Outcomes	<ul style="list-style-type: none"> Pain scores at rest and on movement Analgesic requirement: rescue analgesia Medical complications, gastrointestinal: nausea and vomiting Short-term rehabilitation milestones: day of first walk
Notes	<p>The study also contained a third group who received continuous epidural analgesia with 0.1 mL/kg/h 0.1% bupivacaine (exact number in each group unclear, taken as N = 25)</p> <p>Conference abstract</p> <p>We could not obtain data suitable for analysis</p> <p>Letter sent to study authors 1 July 2016; no reply received</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomly divided", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	Femoral or epidural catheter or no catheter
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not mentioned

Saksena Shrivastava 2011 (Continued)

Selective reporting (reporting bias)	Unclear risk	Limited information
Other bias	Unclear risk	Limited information, "demography comparable"

Shariat 2013

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: St Luke's Roosevelt Hospital, NY, USA</p> <p>Date of data collection: 2010 to 2011</p> <p>Ethics committee: St Luke's Roosevelt Hospital Institutional Review Board approval obtained</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: departmental resources only</p>
Participants	<p>32 (ASA 1 to 3) participants aged 18 to 75 years who had undergone hip arthroplasty and presented with pain score ≥ 3 (scale 0 to 10) at 30 minutes after surgery despite IV patient-controlled analgesia with morphine in post anaesthesia care unit (recruited before surgery but randomized after)</p> <p>Exclusion criteria: allergy to local anaesthetics and/or opioids, body mass index $> 35 \text{ kg/m}^2$, opioid dependence, and pain numeric rating scale ≤ 3 after total hip arthroplasty upon arrival to the PACU</p> <p>Surgery: lateral approach</p>
Interventions	<p>Intervention: single injection fascia iliaca block with 30 mL 0.5% ropivacaine (N = 16)</p> <p>Control: sham block (N = 16)</p> <p>All participants: surgery under general anaesthesia with midazolam, fentanyl, propofol, desflurane and rocuronium</p>
Outcomes	<ul style="list-style-type: none"> Pain scores at rest at 0.5, 1 and 24 h Analgesic requirement: opioid consumption at 0.5, 1, 2 and 24 h after surgery
Notes	<p>Clinicaltrials.gov NCT01758497</p> <p>Additional information received from authors</p> <p>DOI 10.1097/AAP.0b013e31828a3c7c</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomly allocated by the method of sealed envelopes"
Allocation concealment (selection bias)	Low risk	"...randomly allocated by the method of sealed envelopes"
Blinding of participants and personnel (performance bias)	Low risk	"...30 mL 0.5% ropivacaine (fascia iliaca block group) or 30 mL 0.9% NaCl (SB group) beneath the fascia iliaca. The patient, anaesthesiologist performing the block, and research staff conducting the patient evaluations were blinded

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Shariat 2013 (Continued)

All outcomes		to treatment allocation. Research team members mixing the study solutions were not involved in block performance or patient assessment"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"...30 mL 0.5% ropivacaine (fascia iliaca block group) or 30 mL 0.9% NaCl (SB group) beneath the fascia iliaca. The patient, anaesthesiologist performing the block, and research staff conducting the patient evaluations were blinded to treatment allocation. Research team members mixing the study solutions were not involved in block performance or patient assessment"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Unclear risk	"...data presented after enrolment of 28 participants". Mean pain before intervention was 1 point higher in the fascia iliaca group (32 participants), the difference was not statistically significant. VAS scores reported to be lower in the sham block group at 24 h but the change (from 7.2 to 4.8 versus 6.2 to 2.4 for fascia iliaca block and sham block respectively) seem similar

Siddiqui 2007

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic opioids</p> <p>Site: Tufts-New England Medical Center, Tufts University School of Medicine, Boston, MA, USA</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: approved by the Institutional Review Board of Tufts-New England Medical Center</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: charity, Saltonstall Fund for Pain Research</p>
Participants	<p>34 (ASA 1 to 3) participants aged 18 to 80 years undergoing elective unilateral total hip arthroplasty</p> <p>Exclusion criteria: heparin within 4 h of surgery; history of local anaesthetic or morphine allergy; significant cardiovascular, respiratory, renal, hepatic, metabolic disease, or bleeding disorders; cognitive dysfunction; or morbid obesity (body mass index > 40)</p>
Interventions	<p>Intervention: continuous psoas compartment block with 10 mL/h bupivacaine 0.125% for 36 h (N = 17)</p> <p>Control: no block (N = 17)</p> <p>All participants: general anaesthesia with fentanyl, propofol, nitrous oxide and isoflurane, and IV patient-controlled analgesia</p> <p>5 mg warfarin on the evening of surgery and 5 mg each night thereafter</p>
Outcomes	<ul style="list-style-type: none"> Pain scores at rest at 1, 4, 8, 12, 16, 20, 24 and 36 h after surgery Analgesic requirement: opioid consumption at 36 h Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting * cardiovascular: hypotension (requiring vasopressors), blood loss * other: respiratory depression, pruritus

Siddiqui 2007 (Continued)

- Participant satisfaction (4-point Likert scale)

Notes	Emailed study authors 1 July 2016; no reply received DOI 10.1016/j.rapm.2007.04.008
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Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"For the randomization, we used a computer-generated random number program"
Allocation concealment (selection bias)	Low risk	"...for allocation concealment, we used sealed sequentially numbered envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	"Patients or evaluators were not blinded to group assignment"
Blinding of outcome assessment (detection bias) All outcomes	High risk	"Patients or evaluators were not blinded to group assignment"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	Groups well balanced

Singelyn 2005

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia or neuraxial block Site: Université Catholique de Louvain School of Medicine, St Luc Hospital, Brussels, Belgium Date of data collection: unspecified Ethics committee: institutional review board approval Informed consent: oral informed consents Funding: departmental resources
Participants	45 (ASA 1 to 3) participants aged 18 to 80 years undergoing elective unilateral total hip replacement (not minimally invasive) Exclusion criteria: aged up to 18 years or over 80 years, weight < 50 kg or > 100 kg, had pre-existing neurologic deficit or diabetes, or were unable to understand pain scales or use a patient-controlled analgesia device
Interventions	Intervention: continuous femoral nerve block (N = 15)

Singelyn 2005 (Continued)

Control 1: IV patient-controlled analgesia (N = 15)

Control 2: epidural analgesia (N = 15)

General anaesthesia with sufentanil, propofol, desflurane and atracurium for all participants

Rescue analgesia with propacetamol, IM piritramid

Wound drainage

Outcomes	<ul style="list-style-type: none"> Pain at rest and at movement at 4, 24 and 48 h Analgesic requirement: opioids consumption Medical complications <ul style="list-style-type: none"> * cardiovascular: hypotension (30% reduction in systolic blood pressure), blood loss, transfusion * other: urinary retention Use of resources: length of hospital stay (discharge criteria were ability to walk and climb and descend 10 stairs) Short-term rehabilitation milestones: hip flexion Participant satisfaction
Notes	<p>Letter sent to study authors 1 July 2016; no reply received</p> <p>DOI 10.1016/j.rapm.2005.05.008</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomized fashion by use of a computer-generated list of random permutations"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants received femoral, epidural or no catheter
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up, no failed block
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	Groups similar for demographic data

Souron 2003

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus neuraxial block</p>
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Souron 2003 (Continued)

Site: Clinique Générale, Annecy, France

Date of data collection: unspecified

Ethics committee: approved by the local ethics committee

Informed consent: informed consents obtained

Funding: departmental resources

Participants	<p>56 (ASA 1 to 2) participants scheduled for primary hip arthroplasty</p> <p>Exclusion criteria: renal dysfunction, allergy to morphine, local anaesthetics, NSAIDs and propacetamol, preoperative respiratory insufficiency, coagulopathy, and/or treatment with anticoagulants or aspirin</p> <p>Surgery: posterior approach</p>
Interventions	<p>Intervention: single injection psoas compartment block (N = 26)</p> <p>Control: intrathecal morphine 0.1 mg (N = 27)</p> <p>All participants: general anaesthesia with sufentanil, propofol, nitrous oxide, sevoflurane and atracurium and propacetamol, ketoprofen and rescue IV morphine</p>
Outcomes	<ul style="list-style-type: none"> • Pain every 30 min for two h, every six h over 24 h and at 48 h • Analgesic requirement: opioid consumption in post anaesthesia care unit and at 24 and 48 h • Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting * cardiovascular: hypotension (requiring unusual amounts of IV ephedrine and/or fluids) * other: respiratory depression (< 10 breaths per minute), urinary retention, pruritus • Participant satisfaction
Notes	<p>Additional information received from study authors</p> <p>Participants were followed during hospital stay</p> <p>DOI 10.1007/BF03018643</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomly assigned to one of two groups (sealed envelopes)"
Allocation concealment (selection bias)	Low risk	"...randomly assigned to one of two groups (sealed envelopes)"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	<p>"...general anaesthesia was induced by an anaesthesiologist blinded to group assignment"</p> <p>Surgeons and nurses were blinded to the treatment group</p> <p>Participants were not entirely blinded</p>
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Within 30 minutes before general anaesthesia, a senior anaesthesiologist... (highly trained in both techniques and not involved in the postoperative evaluation of the patients) performed either a spinal or a psoas compartment block."

Souron 2003 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Low risk	56 recruited and 53 analysed
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	"There was no difference in age, height, weight or gender"

Stevens 2000

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: Hopitaux Universitaires de Geneve, Switzerland Date of data collection: unspecified Ethics committee: institutional review board approval obtained Informed consent: written informed consents obtained Funding: departmental resources only	
Participants	60 participants undergoing elective total hip arthroplasty Exclusion criteria: contra-indications to regional anaesthesia, use of opioids during the pre-operative period, and dementia preventing proper comprehension of the study	
Interventions	<p>Intervention: single injection psoas compartment block (N = 28)</p> <p>Control: no block (N = 29)</p> <p>All participants: general anaesthesia with fentanyl, thiopental, nitrous oxide, isoflurane and mivacurium or vecuronium (after block performance) for the surgery and IV patient-controlled analgesia with morphine, propacetamol and ibuprofen for postoperative analgesia</p> <p>Most study participants had been enrolled in an autologous blood transfusion program (plexus group, 24/30 participants; control group, 19/30 participants. Blood was systematically transfused within 48 h, no heterologous blood was administered</p> <p>Wound drainage for 48 h</p>	
Outcomes	<ul style="list-style-type: none"> Pain at every 30 min in the PACU and then 6, 12, 24 and 48 h Analgesic requirement: opioid consumption 6, 12, 24 and 48 h Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting * cardiovascular: blood loss Participant satisfaction 	
Notes	Letter sent to study authors 6 July 2016; no reply received	

Risk of bias

Bias	Authors' judgement	Support for judgement
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Stevens 2000 (Continued)

Random sequence generation (selection bias)	Unclear risk	"...randomly allocated"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Low risk	"In conformity with the blinded study design, the anaesthesiologist responsible for the patient was temporarily absent during treatment allocation, leaving the patient in the care of an attending anaesthesiologist. The attending anaesthesiologist administered the block when assigned, then transferred the patient to the initial staff"
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"In the control group, lumbar skin was perforated with use of a needle, but no placebo was administered... Pain scores were assessed by observers who were blind to treatment allocation"
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Two participants, one in each group, were excluded from analysis of postoperative data because of delirium, impeding accurate evaluation... one participant in the plexus group received a dose of local anaesthetic incompatible with the study requirement and was excluded from intra- and postoperative analysis"
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	Groups similar for age, sex distribution, ASA physical status, arterial hypertension and pre-operative pain at rest and on movement

Stevens 2007

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: Latrobe Regional Hospital, Traralgon, Victoria, Australia Date of data collection: unspecified Ethics committee: local hospital ethics committee approval obtained Informed consent: obtained Funding: unspecified
Participants	50 (ASA 1 to 3) participants undergoing unilateral total hip replacement Exclusion criteria: preference for general anaesthesia, contra-indication for subarachnoid block, allergies to drugs used and chronic opioid usage
Interventions	Intervention: single injection fascia iliaca (N = 22) Control: sham block (N = 22) All participants: spinal anaesthesia for surgery and patient-controlled analgesia with morphine for postoperative analgesia
Outcomes	<ul style="list-style-type: none"> Pain at 3, 6, 12 and 24 h

Nerve blocks or no nerve blocks for pain control after elective hip replacement (arthroplasty) surgery in adults (Review)

Stevens 2007 (Continued)

- Analgesic requirement; opioids consumption at 3, 6, 12 and 24 h
- Medical complications
 - * gastrointestinal: nausea and vomiting
 - * cardiovascular: blood loss

Notes Letter sent to study authors 6 July 2016; no reply received

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomisation was performed using a numerical sequence derived from a random number table"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Low risk	"Sham block", no details on who prepared the solution
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Sham block... This was recorded by the recovery and ward nursing staff who, like the surgeon and the patient, were unaware of the group to which the patient had been assigned"
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	"Six patients were ultimately excluded from the study due to the above exclusion criteria or breaches in the study protocol or inadequate data collection. No data were available for analysis of these six excluded patients"
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	"...no statistical difference across the study groups for these characteristics age, gender and ASA physical status"

Striebel 1993

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: Klinikum Steglitz der FU Berlin, Germany</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: approved by the ethics committee</p> <p>Informed consents: obtained</p> <p>Funding: partial support from the industry</p>
Participants	<p>40 participants who had undergone total hip replacement (4 participants undergoing re-operation (2 in each group))</p> <p>Exclusion criteria: intolerance to pethidine or allergy to amide local anaesthetics, neurological disease of the lower limbs</p>

Striebel 1993 (Continued)

Interventions	<p>Intervention: femoral (3-in-1 block) with two doses of 0.5% bupivacaine (N = 20)</p> <p>Control: no block (N = 20)</p> <p>All participants: general anaesthesia for the surgery and "demand-adapted intravenous meperidine titration" for postoperative analgesia</p>
Outcomes	<ul style="list-style-type: none"> • Pain scores at 15, 30 and 60 minutes and at 2, 4 and 6 h • Analgesic requirements: meperidine at 0 to 6 h • Satisfaction scores (reversed 1 to 6 scale)
Notes	<p>Letter sent to study authors 6 July 2016. Response received indicating the contact author was no longer working at the address provided in the report</p> <p>Because participants undergoing repeated surgery constituted a minority of the participants included (4/10), we retained the trial in the review and meta-analyses</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...randomised prospective study... Participants were randomised according to a randomisation list"
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	No sham block
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	Outcomes mentioned in the methods section are reported in results section
Other bias	Low risk	Groups similar for demographic data

Thomas 2009

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus IV lidocaine</p> <p>Site: St Luc Hospital, Brussels, Belgium</p> <p>Date of data collection: not mentioned</p> <p>Ethics committee: not mentioned</p> <p>Informed consent: not mentioned</p>
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Thomas 2009 (Continued)

Funding: unspecified

Participants	Participants undergoing total hip arthroplasty
Interventions	<p>Intervention: continuous femoral nerve block for 24 h and IV saline (N = 10)</p> <p>Control: IV lidocaine infusion and saline continuous femoral nerve block (N = 10)</p> <p>All participants: IV morphine patient-controlled analgesia with morphine and paracetamol 4 g/24 h</p>
Outcomes	<ul style="list-style-type: none"> Pain at rest and on movement (hip flexion) at 2, 24 and 48 h, day 8, 1 month and 3 months Analgesic requirement: at 24 and for the 24 h to 48 h period Short-term rehabilitation milestones: hip flexion at postoperative day 3
Notes	<p>Conference abstract</p> <p>Authors confirmed that original data were no longer available</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomly assigned", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Sham block and infusion to both groups, no details on who prepared the solutions
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Sham block and infusion for all participants: therefore the outcome assessor could not know which participants received a block with local anaesthetics or with a saline solution
Incomplete outcome data (attrition bias) All outcomes	Low risk	No failed block reported
Selective reporting (reporting bias)	Low risk	Limited information, (conference abstract) but no evidence of selective reporting
Other bias	Low risk	"Demographic data (age 71 ± 8 years), preoperative pain (VAS 4.4 ± 2.5), length of surgery (140 ± 44 min), intraoperative sufentanil ($20. \pm 3.7$ µg) were comparable between the groups"

Thybo 2016

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: Naestved Hospital, Ringstedgade, Naestved, Denmark</p> <p>Date of data collection: 3 March 2014 to 1 October 2014</p>
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Thybo 2016 (Continued)

Ethics committee: approved by local Regional Ethics Committee, Region Zealand, Allén 15, 4180 Sorø, (SJ-367, 16 December 2013) and the Danish Data Protection Agency

Informed consent: written informed consents obtained

Funding: departmental resources

Surgery: posterior approach

Participants	120 participants undergoing primary total hip arthroplasty under spinal anaesthesia Exclusion criteria: allergy to local anaesthetics, revision arthroplasty, bilateral arthroplasty, fertile women, daily opioid use
Interventions	Intervention: single injection ultrasound guided lateral femoral cutaneous nerve (N = 47) Control: saline block (N = 53) All participants: spinal anaesthesia for the surgery, 1 g paracetamol administered orally at 6 h intervals and 600 mg ibuprofen administered orally at 8 h intervals initiated immediately after the surgery Rescue analgesia with oral or IV oxycodone
Outcomes	<ul style="list-style-type: none"> Pain at rest and on movement (30 ° flexion of the hip) 0, 1, 2, 4, 8, 12, and 24 h Analgesic requirement: time to first request of rescue analgesic, opioids consumption at 0 to 24 h Use of resources: length of hospital stay Short-term rehabilitation milestones: time to first mobilization, ability to mobilize
Notes	<p>Trial registration: EudraCT: 2013-004501-12 (16 December 2013) and clinicaltrials.gov (NCT02289937) (12 November 2014)</p> <p>Emailed study authors 9 July 2016; no reply received</p> <p>DOI 10.1186/s12871-016-0183-4</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomisation was based on a computer-generated randomisation list, in a ratio of 1:1"
Allocation concealment (selection bias)	Low risk	"The randomisation list and sealed, opaque envelopes were made by a secretary with no further involvement in this trial. Upon inclusion, subjects received treatment assigned according to the randomisation list, in consecutive numbered, opaque, sealed envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	<p>"Patients, assessors and all staff involved with patient care were blinded to the intervention"</p> <p>"The study medication was prepared by a nurse according to the randomisation list. This was verified by a second nurse. These nurses were not further involved in treating the patient, or in the trial. The study medication was prepared in a syringe and labelled with the patient's id-number and the number according to the randomisation list. Ropivacaine and saline are visually indistinguishable. All investigators, patients, outcome assessors, and clinical personnel were blinded to the intervention"</p>
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Patients, assessors and all staff involved with patient care were blinded to the intervention"

Thybo 2016 (Continued)

		"The study medication was prepared by a nurse according to the randomisation list. This was verified by a second nurse. These nurses were not further involved in treating the patient, or in the trial. The study medication was prepared in a syringe and labelled with the patient's id-number and the number according to the randomisation list. Ropivacaine and saline are visually indistinguishable. All investigators, patients, outcome assessors, and clinical personnel were blinded to the intervention"
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	"In the case of failure of the spinal anaesthesia and conversion to general anaesthesia the participant would be removed from the trial and replaced" "20 did not complete the study. These were distributed equally between the ropivacaine and placebo group. Reasons for exclusion were administration of opioids other than prescribed in the study protocol, inadequate spinal anaesthesia with conversion to general anaesthesia, or daily use of opioids prior to surgery that the patient neglected to inform the investigators about until after the surgery"
Selective reporting (reporting bias)	Unclear risk	"Due to unforeseen difficulties obtaining data for all subject we had only few VAS-scores for T8 and T12"
Other bias	Unclear risk	"The subjects' characteristics did not differ between the two groups" No intention-to-treat

Twyman 1990

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: Royal National Orthopaedic Hospital, London, UK Date of data collection: unspecified Ethics committee: not mentioned Informed consent: not mentioned Funding: departmental resources
Participants	20 women undergoing cemented primary total hip replacement for osteoarthritis Cemented prosthesis
Interventions	Intervention: single injection psoas compartment block (N = 10) Control: no block (N = 10) Normotensive general anaesthesia for the surgery and wound drainage for 24 h for all participants
Outcomes	<ul style="list-style-type: none"> Medical complications, cardiovascular: blood loss (weighing sponges and blood in suction bottles and drains)
Notes	Letter sent to study authors 10 July 2016; no reply received DOI 0301-620X/90/5164

Risk of bias

Twyman 1990 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomly allocated", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not mentioned
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	"There was no significant difference between the mean ages and weights of the two groups"

Türker 2003

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus neuraxial block</p> <p>Site: Uludag University Medical Faculty, Bursa, Turkey</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: approved by Uludag University Ethics Committee</p> <p>Informed consent: obtained</p> <p>Funding: unspecified</p>
Participants	<p>30 ASA 1 to 3 participants undergoing unilateral partial hip replacement</p> <p>Exclusion criteria: contra-indications to regional anaesthesia; known allergy to any local anaesthetic; dementia preventing proper comprehension; and refusal of the procedure</p>
Interventions	<p>Intervention: continuous psoas compartment block (N = 15)</p> <p>Control: continuous epidural analgesia (N = 15)</p> <p>All participants: general anaesthesia with fentanyl, propofol, nitrous oxide, sevoflurane and vecuronium</p> <p>Rescue analgesia with diclofenac</p> <p>Enoxaparin 40 mg daily started on postoperative day 1 and continued for five days</p>

Türker 2003 (Continued)

Outcomes	<ul style="list-style-type: none"> • Pain at rest and on movement at 0, 6, 12, 24 and 48 h • Medical complications <ul style="list-style-type: none"> * cardiovascular: hypotension (> 30% below baseline), blood loss (volume of blood in the suction container plus an estimate from the number of surgical dressings used (40 mL blood/dressing)) * gastrointestinal: nausea and vomiting * thromboembolic: deep venous thrombosis (in-hospital routine contrast venography) * other: pruritus, urinary retention • Short-term rehabilitation milestones: time to ambulation • Participant satisfaction
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Notes	<p>Emailed study authors 9 July 2016; no reply received</p> <p>Follow up email and letter 27 May 2017</p>
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Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomized", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	<p>"During the operation, each patient's mean arterial [blood pressure], heart rate, central venous pressure, SpO₂, and end-tidal sevoflurane concentration (%) were recorded at 10-min intervals by a resident anaesthesiologist who was blinded to the type of regional block used"</p> <p>"All pain and motor assessments were carried out by nurses who were blinded to the type of block performed on the patient"</p>
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"...single blind trial... All pain and motor assessments were carried out by nurses who were blinded to the type of block performed on the patient"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	"There were no statistically significant differences in the groups' demographic data"

Uhrbrand 1992

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: Sønderborg Hospital, Denmark</p> <p>Date of data collection: unspecified</p>
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Uhrbrand 1992 (Continued)

Ethics committee: approved by the research ethics board of the municipality of Soenderjylland, Ribe and Ringkoebing

Informed consent: informed consents obtained

Funding: unspecified

Participants	182 participants undergoing total hip arthroplasty Cemented prosthesis, posterior approach
Interventions	Intervention: single injection femoral (3-in-1) block plus single injection lateral femoral cutaneous nerve block (N = 90) Control: no block (N = 89) All participants: general anaesthesia with fentanyl, thiopental, nitrous oxide, enflurane and pancuronium
Outcomes	Analgesic requirement
Notes	Letter sent to study authors 10 July 2016; no reply received

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomised", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not mentioned
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"The recovery ward staff was not informed of the patients allocation to either of the two groups"
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Three patients (nerve block group) were excluded from the investigation. One patient could not cooperate, and another patient had had a groin operation which made the femoral nerve impossible to locate. The last patient was excluded because of a hematoma in the groin after accidental puncture of the femoral artery"
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	"The groups were not significantly different for age, sex and weight"

Utebey 2009

Methods	Parallel RCT Comparison: peripheral nerve block versus neuraxial block or systemic analgesia
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Utebey 2009 (Continued)

Site: Dişkapi Yildirim Beyazit Training and Research Hospital, Ankara, Turkey

Date of data collection: unspecified

Ethics committee: approved by the ethics committee of Training and Research Hospital, Ankara, Turkey

Informed consent: verbal consents obtained

Funding: unspecified

Participants	45 (ASA 1 or 2) participants undergoing total hip arthroplasty Exclusion criteria: ASA > 2, use of antithrombotic drugs contra-indicating spinal anaesthesia and disagreement with the surgical technique
Interventions	Intervention: continuous lumbar plexus block (repeated doses: 1 before surgery and half dose after 8 h) (N =15) Control 1: continuous lumbar epidural analgesia (N =15) Control 2: no block (N =15) All participants: general anaesthesia with fentanyl, thiopental, nitrous oxide, isoflurane and vecuronium for the surgery and IV patient-controlled analgesia for postoperative analgesia
Outcomes	<ul style="list-style-type: none"> Pain scores at rest and on movement at 0, 1, 2, 3, 4, 5, 6, 14 and 24 h Analgesic requirements: time to first analgesia, morphine consumption for the 0 to 24 h period Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting * cardiovascular: hypotension, Intra-operative and total blood loss, Intraoperative blood transfusion * other: respiratory depression. pruritus, urinary retention
Notes	Letter sent to study authors 10 July 2016; no reply received Study authors did not specify if standard deviations (SD) or standard errors of the mean (SEM) were reported. We contacted study authors in July 2016 but received no reply. We tried to enter data as both SD and SEM. When considered as mean and SDs, data different from other included studies (introducing a high degree of heterogeneity). When entered as mean and SEM, data were similar to other included studies. We therefore considered results from this study as mean and SEM

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...allocated at random", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants received a lumbar plexus catheter or an epidural or no catheter
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned

Utebey 2009 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up
Selective reporting (reporting bias)	Low risk	Measurements mentioned in Methods section are reported in Results section
Other bias	Low risk	"Groups were similar for demographic data"

Van Herreweghe 2015

Methods	Parallel RCT Comparison: peripheral nerve block versus systemic analgesia Site: Leuven and Turnhout, Belgium Date of data collection: unspecified Ethics committee: approved by Institutional Review Board Informed consent: written informed consents obtained Funding: unspecified
Participants	78 participants undergoing total hip arthroplasty
Interventions	Intervention: single injection fascia iliaca block (N = 38) Control: no block (N = 40) All participants: paracetamol, NSAIDs and IV patient-controlled analgesia with morphine for postoperative pain relief
Outcomes	Analgesic requirement: opioid consumption
Notes	Conference abstract Emailed study authors 10 July 2016; no reply received

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomized", no further details
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of participants and personnel (performance bias) All outcomes	Low risk	"...double-blinded, placebo-controlled study"
Blinding of outcome assessment (detection bias)	Low risk	"...double-blinded, placebo-controlled study"

Van Herreweghe 2015 (Continued)

All outcomes

Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up mentioned
Selective reporting (reporting bias)	Unclear risk	Limited information
Other bias	Low risk	"Mean age was 60 and 65 years for the nerve block group and control group, respectively (P = 0.03). Body mass index was comparable for both groups"

Wiesmann 2014

Methods	<p>Parallel RCT</p> <p>Comparison: peripheral nerve block versus systemic analgesia</p> <p>Site: University Hospital Marburg, Germany</p> <p>Date of data collection: unspecified</p> <p>Ethics committee: approved by the ethics committee</p> <p>Informed consent: written informed consents obtained</p> <p>Funding: departmental resources</p>
Participants	<p>80 (ASA 1 or 2) participants aged 50 to 70 years undergoing elective total hip arthroplasty</p> <p>Exclusion criteria: gastro-oesophageal reflux, hiatus hernia, predicted difficult intubation, pregnancy, emergency operation, severe kidney dysfunction, asthma or chronic obstructive pulmonary disease, cardiac disease associated with dyspnoea or smoking habit</p> <p>Non-cemented prosthesis</p>
Interventions	<p>Intervention: single injection femoral nerve block (N = 40)</p> <p>Control: no block (N = 40)</p> <p>All participants: general anaesthesia with fentanyl, propofol, sevoflurane and rocuronium for surgery, dexamethasone 4 mg and dolasetron 25 mg IV for nausea and vomiting prophylaxis, non-opioid analgesia with metamizole and ibuprofen, piritramid (only in postanesthesia care unit) as rescue analgesia</p>
Outcomes	<ul style="list-style-type: none"> Pain at rest up to 24 h Analgesic requirement: opioid consumption Medical complications <ul style="list-style-type: none"> * gastrointestinal: nausea and vomiting * cardiovascular: blood loss * other: respiratory depression (oxygen saturation < 90%)
Notes	<p>Trial registered at German Clinical Trial Register DRKS-ID: DRKS00000752</p> <p>Additional information received from study authors</p>

Risk of bias

Wiesmann 2014 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...sealed envelopes"
Allocation concealment (selection bias)	Low risk	"...sealed envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	No sham block
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up (32 participants with protocol violations retained as intention-to-treat)
Selective reporting (reporting bias)	Low risk	All results provided
Other bias	Low risk	Groups similar for demographic data and preoperative pain at rest Intention-to-treat analysis

Abbreviations and acronyms:

ASA: American Society of Anesthesiologists; LMWH: low molecular weight heparin; MMSE: Mini Mental Status Examination; NSAIDs: non steroidal anti-inflammatory drugs; PaCO₂: carbon dioxide partial pressure; PACU: postoperative anaesthesia care unit; SaPO: pulse oximetry; RCT: randomized controlled trial; SB: systolic blood pressure; SF: short form; VAS: visual/verbal analogue scale; WHO: World Health Organization

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Adali 2011	Different population: no participants with hip arthroplasty
Akhtar 2014	Not RCT: case series of 20 ASA 3 or 4 patients operated under lumbar plexus and sciatic nerve block for lower limb surgeries including hip arthroplasty
Bang 2016	Different population: participants had hip fractures
Berge 2004	Different intervention: participants were randomized to a pain management programme that did not include peripheral nerve blocks
Bogoch 2002	Different study population: this study included participants with hip (N = 58) or knee (N = 57) total arthroplasty receiving either lumbar paravertebral (N = 57) or sham (N = 58) procedure. We were unable to extract data for participants undergoing hip arthroplasty only. The study authors confirmed that data were not retained
Dahl 2012	Not RCT: editorial/comment
Dahn 1999	Different intervention: regional spinal anaesthesia studied

Study	Reason for exclusion
Dahn 2003	Different intervention: regional spinal anaesthesia studied
de Leeuw 2011	Not RCT: observational prospective study
Demirel 2014	Different population: study authors confirmed (13 June 2017): "...all patients we have included to our study had femoral fracture prior to surgery"
Eyi 2014	Different population: dislocated hip after total hip replacement
Finn 2016	Not RCT: literature review
Ghabach 2016	Different population: 28/31 participants had hip fractures
Goitia Arrola 2009	Not RCT: prospective cohort observational study
Nooh 2016	Different population: hip fracture or knee arthroplasty
Pandin 1998	Not RCT: all participants had psoas compartment block
Pavy 2007	Not RCT: "This was a prospective, single centre, open, non-randomised study"
Perrier 2010	Not RCT: "This was a prospective observational study"
Rowley 2013	Not RCT: comment on a RCT, did not contain any original data
Segado Jiménez 2010	Different population: study authors confirmed that the trial included participants both with and without hip fracture undergoing elective hip arthroplasty. The study authors were unable to provide separate data for participants with and without hip fracture
Sun 2014	Different population: participants with femoral neck fracture
Tanzer 2012	Not RCT: "this prospective audit... is a cohort study with only time-related randomisation"
Thybo 2016a	Cross-over trial: no group without peripheral nerve block
Vilchis 2012	Not RCT: "Patients were divided up in a non-randomized fashion in two groups"

ASA: American Society of Anesthesiologists; RCT: randomized controlled trial

Characteristics of studies awaiting assessment *[ordered by study ID]*

NCT02242201

Methods	RCT
Participants	Adults undergoing unilateral primary total hip arthroplasty
Interventions	<p>Intervention 1: continuous posterior lumbar plexus block consisting of bupivacaine</p> <p>Control 1: ropivacaine (120 mL) injected in the periarticular structures by the surgeon</p> <p>Control 2: liposomal bupivacaine (Exparel) with ketorolac and epinephrine (120 mL) injected in the periarticular structures by the surgeon</p>
Outcomes	<ul style="list-style-type: none"> Pain up to three months after surgery Opioid consumption

NCT02242201 (Continued)

- Time to discharge readiness
- Nausea and vomiting

Notes

This study has been completed and accepted for publication. It will be further evaluated for inclusion at the next update

Authors confirmed to us in an email that this trial differed from [Thybo 2016](#)

NCT02344264

Methods

RCT

Participants

Adults who had total hip arthroplasty within 48 hours and VAS scores > 40 during active 30 ° hip flexion despite conventional pain medication

Interventions

Intervention: cutaneous femoris lateralis nerve block: first blockade: ropivacaine 7.5 mg/mL to 8 mL second blockade: placebo: saline 8 mL

Control: cutaneous femoris lateralis nerve block: first blockade: first blockade: placebo: saline 8 mL second blockade: ropivacaine 7.5 mg/mL to 8 mL

Outcomes

Difference in VAS between nervus cutaneous femoris lateralis-blockade and placebo at rest and during active 30 degrees hip flexion

Notes

Protocol - 001-2014 - KHTY,

EudraCT Number: 2014-003730-10

This study has been completed and published in 2016. It will be further evaluated for inclusion at the next update

NCT02568995

Methods

RCT

Participants

Adults undergoing hip arthroplasty

Interventions

Intervention: ultrasound guided 3-in-1 block

Control: infiltration with ropivacaine and ketorolac

Outcomes

- Pain intensity at fixed time intervals during 0-7 days and thereafter at weekly intervals for 1 month
- Rescue morphine consumption during 0 to 4, 4 to 24 and 24 to 48 hours
- Side effects and complications
- Home readiness and length of hospital stay
- Chronic pain intensity measured after 3 and 6 months using the Brief Pain Inventory
- Plasma Cytokine concentration at fixed intervals
- Motor block using Bromage scale
- EQ-5D and HOOS questionnaires

Notes

This study has been completed and published in 2016. It will be further evaluated for inclusion at the next update

Characteristics of ongoing studies [ordered by study ID]

NCT01378949

Trial name or title	Psoas compartment block versus fascia iliaca block after total hip arthroplasty
Methods	RCT
Participants	Adults undergoing total hip arthroplasty
Interventions	Intervention 1: ultrasound guided psoas compartment block Intervention 2: ultrasound guided fascia iliaca block Control: patient-controlled analgesia
Outcomes	Pain
Starting date	September 2011
Contact information	Anatoly Stav, MD, Hillel Yaffe Medical Center, Hadera, Israel, 38100
Notes	The recruitment status of this study is unknown. The completion date has passed and the status has not been verified in more than two years (October 2017)

NCT01782612

Trial name or title	The assessments of the postoperative recovery on elderly patients received general anesthesia or peripheral nerve blocks
Methods	RCT
Participants	Elderly (age > 75 years) adults undergoing elective total uni-hip replacement
Interventions	Intervention: peripheral nerve block (lumbar plexus block and sciatic nerve block with 0.4% ropi-vacaine and multimodal analgesic techniques) Control: general anaesthesia
Outcomes	<ul style="list-style-type: none"> Postoperative recovery by the postoperative quality recovery scale Postoperative delirium Cardiovascular and pulmonary complications Stress and inflammation
Starting date	March 2013
Contact information	Zhang Hong and Wang XiaoLin, Anesthesia and Operation Center, Chinese People's Liberation Army General Hospital, Beijing, Beijing, China, 100853
Notes	The recruitment status of this study is unknown. The completion date has passed and the status has not been verified in more than two years (October 2017)

NCT01875289

Trial name or title	Efficacy of a modified obturator nerve block technique
Methods	RCT
Participants	Adults undergoing hip or knee surgery
Interventions	Intervention: Obturator nerve block with ropivacaine Control: saline injection
Outcomes	<ul style="list-style-type: none"> Adductor strengths
Starting date	July 2013
Contact information	Prof Andreas Sandner-Kiesling, Medical University Graz, Austria
Notes	This study has been completed. Authors have been contacted in October 2017 to obtain more information

NCT01911949

Trial name or title	Ultrasound guided fascia iliaca block at the inguinal ligament for total hip arthroplasty
Methods	RCT
Participants	Adults undergoing hip replacement surgery
Interventions	Intervention: single injection ultrasound guided femoral nerve block with 40 mL bupivacaine 0.5% with epinephrine Control: saline injection
Outcomes	<ul style="list-style-type: none"> Risk of respiratory depression and seizures in participants
Starting date	June 2013
Contact information	St. Joseph's Healthcare Hamilton, Hamilton, Ontario, Canada, L8N 4A6
Notes	This study suspended participant recruitment. (Difficulty recruiting patients. Need more funding)

NCT02056145

Trial name or title	Ultrasound guided lateral femoral cutaneous block (LFCNB) and femoral nerve block for postoperative pain control after hip surgery
Methods	RCT
Participants	Adults undergoing hip arthroplasty with posterolateral approach
Interventions	Intervention 1: single injection femoral and lateral femoral cutaneous nerve blocks under ultrasound guidance, with 20 cc 0.25% bupivacaine solution for the femoral block and 10 cc 0.9% saline solution for lateral femoral cutaneous block, for a total of 20 cc 0.25% bupivacaine solution in 10 cc saline solution 0.9%

NCT02056145 (Continued)

Intervention 2: single injection femoral and lateral femoral cutaneous nerve blocks under ultrasound guidance, with 20 cc 0.25% bupivacaine solution for the femoral block and 10 cc 0.25% bupivacaine solution for lateral femoral cutaneous block, for a total of 30 cc 0.25% bupivacaine solution

Control: single injection femoral and lateral femoral cutaneous nerve blocks under ultrasound guidance, with 20 cc 0.9% saline solution for the femoral block and 10 cc 0.9% saline solution for lateral femoral cutaneous block, for a total of 30 mL saline solution 0.9%

Outcomes	<ul style="list-style-type: none"> • Use of opioids • Pain
Starting date	October 2011
Contact information	Sultan Temurziev, MD, AZ Sint Augustinus, Wilrijk, Antwerpen, Belgium, 2610
Notes	The recruitment status of this study is unknown. The completion date has passed and the status has not been verified in more than two years (October 2017)

NCT02108847

Trial name or title	Ultrasound guided fascia iliaca block for pain control after elective hip replacement surgery
Methods	RCT
Participants	Adults undergoing elective hip replacement
Interventions	<p>Intervention: Fascia iliaca block with 2% ropivacaine</p> <p>Control: Fascia iliaca block with saline</p>
Outcomes	<ul style="list-style-type: none"> • Cumulative opioid consumption up to 48 hours after surgery • Pain scores in the postoperative care unit and at 4, 8, 12, 24 and 48 hours • Opioid side effect (nausea/vomiting, pruritus, constipation, urinary retention, sedation) • Overall patient satisfaction
Starting date	April 2014
Contact information	Jacelyn Larson, MD, Saskatoon City Hospital, Saskatchewan, Canada
Notes	This study has been completed. No email address available. An email has been sent to study authors

NCT02299271

Trial name or title	Fascia iliaca block for postoperative pain control after total hip arthroplasty
Methods	RCT
Participants	Adults undergoing hip arthroplasty
Interventions	<p>Intervention: fascia iliaca with ropivacaine 0.375% as a one-time 60 mL injection</p> <p>Control: saline injection</p>

NCT02299271 (Continued)

Outcomes	<ul style="list-style-type: none"> • Pain • Opioid consumption • Postoperative care unit length of stay
Starting date	June 2014
Contact information	Brian Vaughan, MD, The Christ Hospital, Cincinnati, Ohio, USA, 45219
Notes	This study has been terminated. The authors mentioned that preliminary results did not indicate differences between groups. An email was sent to authors to obtain more information in October 2017

NCT02544269

Trial name or title	Hemodynamic effect of lumbosacral plexus blockade versus spinal anesthesia
Methods	RCT
Participants	Adults undergoing total hip replacement
Interventions	<p>Intervention: peripheral nerve blockade of lumbar and sacral plexus with ropivacaine max 225 mg perineural</p> <p>Control: continuous spinal anaesthesia with plain bupivacaine max 15 mg intrathecal</p>
Outcomes	<ul style="list-style-type: none"> • Change of cardiac output • Time for performance of nerve blocks • Success rate of nerve blocks • Change of cardiac stroke volume • Change of systemic vascular resistance • Change of mean arterial pressure • Change of central venous oxygen saturation • Maximum plasma concentration of ropivacaine • Change of plasma concentration of lactate • Cumulated perioperative propofol dose • Cumulated perioperative opioid dose • Cumulated postoperative opioid dose • Time from end of operation to first opioid dose • Surgeons self reported satisfaction with anaesthesia • Patients worst pain during surgery
Starting date	April 2016
Contact information	Niels D Nielsen, MD, University of Aarhus, Aarhus University Hospital, Silkeborg, Denmark
Notes	This study has been terminated. The authors indicated: "After pilot study no difference in the primary end point was found between the two primary. Non-inferiority trial not deemed feasible". Email sent to authors to obtain more information

NCT02658149

Trial name or title	Psoas compartment block versus periarticular local anaesthetic infiltration for pain management for total hip arthroplasty: A prospective, randomized study
Methods	RCT
Participants	Adults undergoing unilateral primary total hip arthroplasty
Interventions	<p>Intervention: after surgical exposure anaesthetic is introduced directly into the iliopsoas muscle, where it then spreads to the lumbar plexus (the nerves responsible for sensation around the surgical site)</p> <p>Control: an anaesthetic "cocktail" of four drugs is injected at five locations at the surgical site to the surrounding tissues</p>
Outcomes	<ul style="list-style-type: none"> • Pain • Opioid usage in-hospital
Starting date	February 2016
Contact information	James Verner, MD, William Beaumont Hospitals, USA
Notes	This study is currently recruiting participants (October 2017)

NCT02658240

Trial name or title	Ultrasound-guided fascia iliaca compartment block versus periarticular infiltration
Methods	RCT
Participants	Adults undergoing hip arthroplasty
Interventions	<p>Intervention: fascia iliaca compartment block with ropivacaine and epinephrine after surgery</p> <p>Control: periarticular infiltration with ropivacaine and epinephrine prior to closing the incision</p>
Outcomes	<ul style="list-style-type: none"> • Pain
Starting date	February 2016
Contact information	Irina Gasanova, MD, UTSW Parkland Health Hospital System, Dallas, TX, USA 75390
Notes	This study is currently recruiting participants (October 2017)

NCT02720471

Trial name or title	Local analgesia versus local perioperative infiltration after total hip replacement (ALRIAL)
Methods	RCT
Participants	Adults undergoing total hip replacement
Interventions	Intervention: femoral block associated with a side cutaneous block of the thigh

NCT02720471 (Continued)

Control: perioperative infiltration

Outcomes	<ul style="list-style-type: none"> • Opioid consumption • Pain at rest and on movement • Time to first upright posture • Time before walking
Starting date	September 2015
Contact information	Cécile Faulcon and Thomas Rimmele, Hôpital Edouard Herriot, Lyon, France
Notes	This study has been completed. An email has been sent to authors in October 2017 to obtain more information

EQ-5D: Euro-Qual questionnaire; HOOS: Hip dysfunction and Osteoarthritis Outcome Score; LFCNB: lateral femoral cutaneous nerve block; SF: short form; RCT: randomized controlled trial; VAS: visual/verbal analogue scale

DATA AND ANALYSES

Comparison 1. Peripheral nerve blocks versus no block, sham block or systemic analgesia

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain at rest on arrival at postoperative care unit	9	429	Std. Mean Difference (Random, 95% CI)	-1.12 [-1.67, -0.56]
1.1 Femoral nerve block	6	287	Std. Mean Difference (Random, 95% CI)	-1.22 [-2.06, -0.38]
1.2 Psoas compartment block	3	142	Std. Mean Difference (Random, 95% CI)	-0.91 [-1.25, -0.56]
2 Pain at rest from 0.5 to 2 hours after surgery	9	438	Std. Mean Difference (Random, 95% CI)	-0.67 [-1.06, -0.29]
2.1 Femoral nerve block	4	187	Std. Mean Difference (Random, 95% CI)	-0.28 [-0.85, 0.28]
2.2 Fascia iliaca block	2	47	Std. Mean Difference (Random, 95% CI)	-1.21 [-3.34, 0.92]
2.3 Psoas compartment block	4	204	Std. Mean Difference (Random, 95% CI)	-0.91 [-1.20, -0.62]
3 Pain at rest at 4 to 6 hours after surgery	13	599	Std. Mean Difference (Random, 95% CI)	-0.62 [-0.92, -0.32]
3.1 Femoral nerve block	5	223	Std. Mean Difference (Random, 95% CI)	-0.30 [-0.98, 0.38]
3.2 Fascia iliaca block	2	73	Std. Mean Difference (Random, 95% CI)	-0.36 [-1.06, 0.33]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.3 Psoas compartment block	6	303	Std. Mean Difference (Random, 95% CI)	-0.88 [-1.12, -0.64]
4 Pain on movement at 4 to 6 hours after surgery	3	120	Std. Mean Difference (Random, 95% CI)	-0.46 [-1.12, 0.20]
4.1 Femoral nerve block	1	23	Std. Mean Difference (Random, 95% CI)	0.0 [-0.86, 0.86]
4.2 Fascia iliaca block	1	29	Std. Mean Difference (Random, 95% CI)	-0.18 [-0.91, 0.55]
4.3 Psoas compartment block	1	68	Std. Mean Difference (Random, 95% CI)	-1.0 [-1.51, -0.49]
5 Pain at rest at 24 hours after surgery for single injection block with clonidine or continuous nerve block	6	303	Std. Mean Difference (Random, 95% CI)	-0.66 [-1.05, -0.28]
5.1 Femoral nerve block	3	155	Std. Mean Difference (Random, 95% CI)	-0.68 [-1.27, -0.10]
5.2 Fascia iliaca block	1	44	Std. Mean Difference (Random, 95% CI)	0.0 [-0.59, 0.59]
5.3 Psoas compartment block	2	104	Std. Mean Difference (Random, 95% CI)	-0.97 [-1.37, -0.56]
6 Pain on movement at 24 hours after surgery for continuous peripheral nerve block	3	317	Std. Mean Difference (Random, 95% CI)	-0.71 [-1.26, -0.17]
6.1 Femoral nerve block	2	136	Std. Mean Difference (Random, 95% CI)	-0.24 [-0.59, 0.12]
6.2 Psoas compartment block	2	181	Std. Mean Difference (Random, 95% CI)	-1.13 [-1.46, -0.80]
7 Pain at rest at 48 hours after surgery	2	93	Std. Mean Difference (Random, 95% CI)	-0.80 [-1.35, -0.25]
7.1 Continuous femoral nerve block	1	23	Std. Mean Difference (Random, 95% CI)	-0.39 [-1.25, 0.47]
7.2 Continuous psoas compartment block	1	70	Std. Mean Difference (Random, 95% CI)	-0.99 [-1.48, -0.50]
8 Pain on movement at 48 hours after surgery	3	317	Std. Mean Difference (Random, 95% CI)	-0.62 [-1.13, -0.11]
8.1 Continuous femoral nerve block	2	136	Std. Mean Difference (Random, 95% CI)	-0.16 [-0.60, 0.28]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8.2 Continuous psoas compartment block	2	181	Std. Mean Difference (Random, 95% CI)	-0.93 [-1.25, -0.61]
9 Analgesic requirements: opioids consumption from 0 to 24 hours	12	897	Std. Mean Difference (Random, 95% CI)	-0.62 [-0.89, -0.35]
9.1 Femoral nerve block with or without lateral cutaneous nerve block	3	332	Std. Mean Difference (Random, 95% CI)	-0.39 [-0.61, -0.17]
9.2 Fascia iliaca block	5	233	Std. Mean Difference (Random, 95% CI)	-0.84 [-1.27, -0.41]
9.3 Psoas compartment	3	196	Std. Mean Difference (Random, 95% CI)	-0.96 [-1.27, -0.65]
9.4 Obturator nerve block	1	36	Std. Mean Difference (Random, 95% CI)	-0.4 [-1.07, 0.27]
9.5 Lateral femoral cutaneous alone	1	100	Std. Mean Difference (Random, 95% CI)	0.31 [-0.08, 0.70]
10 Gastrointestinal complications: postoperative nausea and vomiting	5	282	Risk Ratio (M-H, Fixed, 95% CI)	0.86 [0.53, 1.41]
11 Cardiovascular complications: hypotension	4	150	Risk Ratio (M-H, Fixed, 95% CI)	0.95 [0.50, 1.81]
12 Cardiovascular complications: intra-operative blood losses (mL)	8	323	Mean Difference (IV, Random, 95% CI)	-52.47 [-170.88, 65.95]
12.1 Femoral nerve block	3	160	Mean Difference (IV, Random, 95% CI)	33.81 [-27.12, 94.75]
12.2 Fascia iliaca block	1	29	Mean Difference (IV, Random, 95% CI)	-3.0 [-216.07, 210.07]
12.3 Psoas compartment block	4	134	Mean Difference (IV, Random, 95% CI)	-181.06 [-451.65, 89.53]
13 Cardiovascular complications: number of blood units transfused	3	82	Mean Difference (IV, Random, 95% CI)	-0.59 [-1.25, 0.08]
13.1 Femoral nerve block	2	59	Mean Difference (IV, Random, 95% CI)	-0.45 [-0.97, 0.07]
13.2 Psoas compartment block	1	23	Mean Difference (IV, Random, 95% CI)	-2.0 [-3.88, -0.12]
14 Neurological complications: drowsiness up to 48 hours after surgery	3	86	Risk Ratio (M-H, Fixed, 95% CI)	0.40 [0.13, 1.18]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
15 Pruritus first 48 hours	4	379	Risk Ratio (M-H, Random, 95% CI)	0.34 [0.09, 1.27]
15.1 Single injection blocks	2	120	Risk Ratio (M-H, Random, 95% CI)	0.92 [0.50, 1.68]
15.2 Continuous peripheral nerve blocks	2	259	Risk Ratio (M-H, Random, 95% CI)	0.16 [0.04, 0.70]
16 Respiratory depression	3	184	Risk Difference (M-H, Fixed, 95% CI)	-0.01 [-0.05, 0.03]
17 Hospital length of stay	3	349	Std. Mean Difference (Random, 95% CI)	-0.56 [-0.91, -0.21]
17.1 Continuous femoral nerve or psoas compartment block	2	249	Std. Mean Difference (Random, 95% CI)	-0.75 [-1.02, -0.48]
17.2 Single injection femoral lateral cutaneous nerve block	1	100	Std. Mean Difference (Random, 95% CI)	-0.13 [-0.52, 0.26]
18 Walking on postoperative day 1	2	278	Risk Difference (M-H, Fixed, 95% CI)	0.01 [-0.03, 0.05]
18.1 Single injection block	1	53	Risk Difference (M-H, Fixed, 95% CI)	0.04 [-0.14, 0.23]
18.2 Continuous nerve block	1	225	Risk Difference (M-H, Fixed, 95% CI)	0.0 [-0.02, 0.02]
19 Hip flexion at 7 days	2	68	Mean Difference (IV, Random, 95% CI)	-1.40 [-9.04, 6.25]
19.1 Single injection femoral nerve or psoas compartment block	1	45	Mean Difference (IV, Random, 95% CI)	-6.12 [-14.53, 2.29]
19.2 Continuous femoral nerve block	1	23	Mean Difference (IV, Random, 95% CI)	4.0 [-3.01, 11.01]
20 Patient satisfaction for continuous peripheral nerve block	4	363	Std. Mean Difference (Fixed, 95% CI)	0.67 [0.45, 0.89]
20.1 Femoral nerve block	3	176	Std. Mean Difference (Fixed, 95% CI)	0.47 [0.15, 0.78]
20.2 Psoas compartment block	3	187	Std. Mean Difference (Fixed, 95% CI)	0.88 [0.57, 1.19]

Analysis 1.1. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 1 Pain at rest on arrival at postoperative care unit. **Analysis 1.2. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 2 Pain at rest from 0.5 to 2 hours after surgery.**

Analysis 1.3. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 3 Pain at rest at 4 to 6 hours after surgery.

Analysis 1.4. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 4 Pain on movement at 4 to 6 hours after surgery.

Analysis 1.5. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 5 Pain at rest at 24 hours after surgery for single injection block with clonidine or continuous nerve block.

Analysis 1.6. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 6 Pain on movement at 24 hours after surgery for continuous peripheral nerve block.

Analysis 1.7. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 7 Pain at rest at 48 hours after surgery.

Analysis 1.8. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 8 Pain on movement at 48 hours after surgery.

Analysis 1.9. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 9 Analgesic requirements: opioids consumption from 0 to 24 hours.

Analysis 1.10. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 10 Gastrointestinal complications: postoperative nausea and vomiting.

Analysis 1.11. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 11 Cardiovascular complications: hypotension.

Analysis 1.12. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 12 Cardiovascular complications: intra-operative blood losses (mL).

Analysis 1.13. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 13 Cardiovascular complications: number of blood units transfused.

Analysis 1.14. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 14 Neurological complications: drowsiness up to 48 hours after surgery.

Analysis 1.15. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 15 Pruritus first 48 hours.

Analysis 1.16. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 16 Respiratory depression. **Analysis 1.17. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 17 Hospital length of stay.**

Analysis 1.18. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 18 Walking on postoperative day 1.

Analysis 1.19. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 19 Hip flexion at 7 days.

Analysis 1.20. Comparison 1 Peripheral nerve blocks versus no block, sham block or systemic analgesia, Outcome 20 Patient satisfaction for continuous peripheral nerve block.

Comparison 2. Peripheral nerve blocks versus neuraxial blocks

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain at rest on arrival in postanaesthesia care unit	4	118	Mean Difference (IV, Fixed, 95% CI)	0.39 [-0.15, 0.94]
2 Pain with movement at arrival in postanaesthesia care unit	2	54	Std. Mean Difference (Fixed, 95% CI)	0.08 [-0.46, 0.62]
3 Pain at rest from 0.5 to 2 hours after surgery	2	66	Mean Difference (IV, Random, 95% CI)	2.63 [0.77, 4.49]
3.1 Femoral nerve or fascia iliaca block	2	42	Mean Difference (IV, Random, 95% CI)	3.45 [2.01, 4.90]
3.2 Femoral plus sciatic nerve block	1	24	Mean Difference (IV, Random, 95% CI)	1.06 [-0.02, 2.14]
4 Pain at rest at 4 to 6 hours after surgery	9	398	Std. Mean Difference (Random, 95% CI)	0.41 [0.11, 0.71]
4.1 Single injection peripheral nerve block	3	176	Std. Mean Difference (Random, 95% CI)	0.29 [-0.61, 1.19]
4.2 Continuous peripheral nerve blocks	6	222	Std. Mean Difference (Random, 95% CI)	0.40 [0.13, 0.67]
5 Pain with movement at 4 to 6 hours after surgery	7	325	Std. Mean Difference (Random, 95% CI)	0.53 [0.20, 0.86]
6 Pain at rest at 24 hours after surgery	8	328	Std. Mean Difference (Random, 95% CI)	0.10 [-0.22, 0.42]
6.1 Single injection block peripheral nerve block	3	163	Std. Mean Difference (Random, 95% CI)	0.05 [-0.26, 0.36]
6.2 Continuous peripheral nerve block	5	165	Std. Mean Difference (Random, 95% CI)	0.12 [-0.42, 0.65]
7 Pain with movement at 24 hours	7	317	Std. Mean Difference (Random, 95% CI)	0.28 [-0.06, 0.62]
7.1 Single injection peripheral nerve block	1	103	Std. Mean Difference (Random, 95% CI)	-0.13 [-0.52, 0.26]
7.2 Continuous peripheral nerve block	6	214	Std. Mean Difference (Random, 95% CI)	0.38 [0.01, 0.75]
8 Pain at rest at 48 hours after surgery	7	289	Std. Mean Difference (Fixed, 95% CI)	0.07 [-0.16, 0.31]
8.1 Single injection shot peripheral nerve block	2	123	Std. Mean Difference (Fixed, 95% CI)	-0.29 [-0.65, 0.07]
8.2 Continuous peripheral nerve block	5	166	Std. Mean Difference (Fixed, 95% CI)	0.35 [0.04, 0.67]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
9 Pain with movement at 48 hours (continuous peripheral nerve blocks only)	5	164	Std. Mean Difference (Random, 95% CI)	0.33 [-0.13, 0.79]
9.1 Bupivacaine infusion	3	77	Std. Mean Difference (Random, 95% CI)	-0.16 [-0.62, 0.30]
9.2 Ropivacaine infusion	2	87	Std. Mean Difference (Random, 95% CI)	0.80 [0.36, 1.24]
10 Total number of nerve block-related complications	5	334	Risk Difference (M-H, Fixed, 95% CI)	-0.00 [-0.05, 0.05]
11 Analgesic requirements: opioids consumption from 0 to 24 hours	4	203	Std. Mean Difference (Random, 95% CI)	0.67 [0.04, 1.31]
11.1 Single injection peripheral nerve block	2	93	Std. Mean Difference (Random, 95% CI)	1.24 [0.79, 1.69]
11.2 Repeated doses peripheral nerve blocks	2	110	Std. Mean Difference (Random, 95% CI)	0.17 [-0.37, 0.71]
12 Gastrointestinal complications: postoperative nausea and vomiting	2	103	Risk Ratio (M-H, Fixed, 95% CI)	0.79 [0.44, 1.39]
13 Cardiovascular complications: hypotension	8	429	Risk Difference (M-H, Random, 95% CI)	-0.09 [-0.22, 0.03]
13.1 Compared to a single injection block or two doses	5	306	Risk Difference (M-H, Random, 95% CI)	0.02 [-0.04, 0.08]
13.2 Compared to a continuous neuraxial block	3	123	Risk Difference (M-H, Random, 95% CI)	-0.34 [-0.48, -0.20]
14 Cardiovascular complications: intra-operative blood losses (mL)	5	188	Mean Difference (IV, Random, 95% CI)	-8.84 [-80.82, 63.14]
15 Cardiovascular complications: number of units transfused	3	87	Mean Difference (IV, Random, 95% CI)	-0.23 [-0.65, 0.19]
16 Neurological complications: drowsiness up to 48 hours after surgery	3	176	Risk Difference (M-H, Random, 95% CI)	0.04 [-0.07, 0.15]
16.1 Compared to intrathecal opioids	2	156	Risk Difference (M-H, Random, 95% CI)	0.01 [-0.03, 0.05]
16.2 Compared to epidural analgesia	1	20	Risk Difference (M-H, Random, 95% CI)	0.4 [0.04, 0.76]
17 Thromboembolic complications: deep venous thrombosis	2	100	Risk Difference (M-H, Fixed, 95% CI)	0.0 [-0.05, 0.05]
18 Pruritus	6	299	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.19, 0.58]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
19 Respiratory depression	4	213	Risk Difference (M-H, Fixed, 95% CI)	0.01 [-0.03, 0.05]
20 Hospital length of stay	2	64	Mean Difference (IV, Fixed, 95% CI)	0.19 [-0.39, 0.77]
21 Time to start rehabilitation: bed to chair	2	144	Std. Mean Difference (Random, 95% CI)	0.19 [-0.34, 0.72]
21.1 Single injection block peripheral nerve block	1	103	Std. Mean Difference (Random, 95% CI)	0.41 [0.02, 0.80]
21.2 Continuous peripheral nerve block	1	41	Std. Mean Difference (Random, 95% CI)	-0.14 [-0.75, 0.47]
22 Walking	3	94	Mean Difference (IV, Random, 95% CI)	-0.41 [-1.09, 0.27]
23 Patient satisfaction	6	307	Std. Mean Difference (Random, 95% CI)	0.08 [-0.32, 0.48]
23.1 Single injection peripheral nerve block	3	196	Std. Mean Difference (Random, 95% CI)	-0.24 [-0.68, 0.19]
23.2 Continuous peripheral nerve block	3	111	Std. Mean Difference (Random, 95% CI)	0.54 [0.16, 0.93]

Analysis 2.1. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 1 Pain at rest on arrival in postanaesthesia care unit.

**Analysis 2.2. Comparison 2 Peripheral nerve blocks versus neuraxial blocks,
Outcome 2 Pain with movement at arrival in postanesthesia care unit.** **Analysis 2.3. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 3 Pain at rest from 0.5 to 2 hours after surgery.** **Analysis 2.4. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 4 Pain at rest at 4 to 6 hours after surgery.**

Analysis 2.5. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 5 Pain with movement at 4 to 6 hours after surgery.

Analysis 2.6. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 6 Pain at rest at 24 hours after surgery. **Analysis 2.7. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 7 Pain with movement at 24 hours.**

Analysis 2.8. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 8 Pain at rest at 48 hours after surgery.

Analysis 2.9. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 9 Pain with movement at 48 hours (continuous peripheral nerve blocks only).

Analysis 2.10. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 10 Total number of nerve block-related complications.

Analysis 2.11. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 11 Analgesic requirements: opioids consumption from 0 to 24 hours.

Analysis 2.12. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 12 Gastrointestinal complications: postoperative nausea and vomiting.

Analysis 2.13. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 13 Cardiovascular complications: hypotension.

Analysis 2.14. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 14 Cardiovascular complications: intra-operative blood losses (mL).

Analysis 2.15. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 15 Cardiovascular complications: number of units transfused.

Analysis 2.16. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 16 Neurological complications: drowsiness up to 48 hours after surgery.

Analysis 2.17. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 17 Thromboembolic complications: deep venous thrombosis.

Analysis 2.18. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 18 Pruritus.

Analysis 2.19. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 19 Respiratory depression.

Analysis 2.20. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 20 Hospital length of stay.

Analysis 2.21. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 21 Time to start rehabilitation: bed to chair.

Analysis 2.22. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 22 Walking.

Analysis 2.23. Comparison 2 Peripheral nerve blocks versus neuraxial blocks, Outcome 23 Patient satisfaction. **ADDITIONAL TABLES****Table 1. Details of nerve blocks and complications related to analgesic techniques**

Study	Regional anaesthesia technique	Complications related to regional anaesthesia	Analgesic technique	Complications related to systemic analgesia or general anaesthesia
Aksoy 2014	<p>Ultrasound to localize the spinous process of L3. Psoas compartment block with 30 mL 0.25% bupivacaine and epinephrine 5 µg/mL injected when an ipsilateral quadriceps muscle contraction was obtained at 0.5 to 0.8 mA.</p> <p>Subgluteal sciatic nerve block with 20 mL of the same solution (dual guidance and plantar flexion at 0.5 to 0.8 mA Karmakar 2007).</p> <p>Iliac crest block with 5 mL of the same solution.</p> <p>Continuous spinal anaesthesia (22G; catheter over the needle) for the surgery for the comparator</p>	<p>No major complications due to the peripheral nerve block procedure were observed in any participants intra- or postoperatively</p> <p>No participant had post dural puncture headache in the continuous spinal anaesthesia group until discharged. Cauda equina syndrome was not ob-</p>	<p>Subcutaneous morphine 0.1 mg/kg for the peripheral nerve block group.</p> <p>Intrathecal morphine 0.2 mg for the comparative group.</p> <p>Rescue analgesia with IV tramadol 50 mg</p>	<p>Complications related to morphine (any route) not reported.</p> <p>No significant difference in terms of peripheral oxygen saturation</p>

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

		served in any participant		
Anis 2011	Nerve stimulation psoas compartment block (Capdevila 2002) with 15 mL 0.5% bupivacaine plus 15 mL saline ± clonidine 2.5 µg/mL (total 75 µg) injected when a quadriceps contraction was obtained at 0.5 mA and 50 ms	No local anaesthetics side effects occurred during the first 24 hours post-operatively	IM morphine	Respiratory rate was in the normal range after 2 hours postoperatively for systemic analgesia group participants Mean respiratory rate was above 10 per minute for all groups at 2, 6 and 12 hours
Asano 2010	Continuous lumbar plexus block ultrasound and nerve stimulation guidance: injection 0.6 mL/kg of 0.375% ropivacaine and 100 µg fentanyl through the stimulating needle, advancement of the catheter to the local anaesthetic pool with ultrasound guidance, followed by continuous infusion of 0.2% ropivacaine at 6 mL to 8 mL/hour plus fentanyl (0.5 µg/kg/hour). Continuous lumbar epidural (L2-L3) with 4 mL ropivacaine 0.75% plus 100 µg of fentanyl, followed by continuous infusion of 0.2% ropivacaine at 4 mL/hour plus fentanyl (0.5 µg/kg/hour)	Not reported	IV patient controlled analgesia with fentanyl	Not reported
Bakalov 2016	Quadratus lumborum block (Blanco 2015)	Not reported	Paracetamol, ketoprofen and IV morphine patient-controlled analgesia	Vomiting
Becchi 2008	Nerve stimulation psoas compartment block (Capdevila 2002). When a quadriceps contraction was obtained between 0.3 and 0.5 mA and 100 ms, the needle bevel was oriented caudally and laterally, the psoas compartment was distended with 5 mL saline, and a 20 G multi-perforated catheter was introduced through the needle and advanced 5 cm distally to the needle tip. A test dose of 1% lidocaine with epinephrine 5 µg/mL (3 mL) was performed. If the test dose was negative, 10 mL contrast medium (Omnipaque; Amersham Health, Oslo, Norway) was injected into the catheter, and an antero-posterior radiograph of the lumbar region was obtained. Catheter location was evaluated by a radiologist. 30 min before the end of surgery, participants received a loading dose 0.75% ropivacaine (0.4 mL/kg) followed by an infusion of 0.2% ropivacaine at 10 mL/hour for 48 hours. Spinal anaesthesia with a 27 G Whitacre needle at L3-L4 and 15 mg isobaric bupivacaine	No participant developed haematoma related to catheter, haemodynamic disturbances (bradycardia, hypotension or both). There was no epidural spread, dysaesthesia or any other sign of local anaesthetic toxicity. One catheter displacement occurred during the study period and no neurological complications were	IV infusion of morphine 0.1% and ketorolac 0.12% at 2 mL/hour for 48 hours	No participant had itching or respiratory depression

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

		recorded after catheter withdraw- al		
Bhatia 2008	Psoas compartment block with a nerve stimulator and 0.4 mL/kg 0.125% levobupivacaine before surgery, catheter inserted, and re-injection of the same dose of levobupivacaine at the end of surgery	Not reported	Intrathecal diamorphine 4 µg/kg. IV patient-controlled analgesia with morphine	Not reported
Biboulet 2004	Femoral nerve block with nerve stimulation (Winnie 1973) and 2 mg/kg 0.375% bupivacaine and 2 µg/kg clonidine or Psoas compartment block at L3 with nerve stimulation (Parkinson 1989) and 2 mg/kg of 0.375% bupivacaine and 2 µg/kg of clonidine	Except for 4 cases of epidural anaesthesia (lasting < 4 hours) in the psoas compartment block group, no complications secondary to the block were noted	IV patient-controlled analgesia with morphine. All participants systematically received 2 g IV propacetamol every 6 hours during 48 hours (first dose 30 minutes before the end of surgery) and 50 mg indomethacin intra-rectally at the end of surgery and 25 mg orally every 12 hours during 48 hours	There was no difference in respiratory rate among the three groups during the study. No participants reported pruritus. Sedation scores in all participants were < 1 for the first 8 postoperative hours and rated 0 after 8 hours
Bichel 1998	Femoral nerve block with a nerve stimulator and 0.3 mL/kg 0.5% bupivacaine followed by an infusion of bupivacaine 0.125% and sufentanil 0.5 µg/mL at 10 mL/hour. Lumbar epidural (L2-L3 or L3-L4) with 0.3 mL/kg 0.5% bupivacaine followed by an infusion of 0.125% bupivacaine and sufentanil 0.5 µg/mL at 6 mL/hour	Not reported	IM piritramide	Not reported
Borisov 2012	Continuous fascia iliaca block, catheters threaded 3 cm cranially and loaded with 30 mL 0.33% ropivacaine followed by an infusion of 0.2% ropivacaine at 1 mg/10 kg continued for 48 hours. Continuous epidural (combined spinal /epidural) with catheters threaded 3 cm to 5 cm cranially and an infusion of 0.2% ropivacaine started after surgery. Spinal anaesthesia with 15 mg 0.5% hyperbaric 0.5% bupivacaine at L2-L3 or L3-L4 with the needle oriented cranially for surgery	There were no complications related to regional anaesthesia, intra- or postoperative techniques. One failed catheter in the fascia iliaca block group	Acetaminophen 4 g/day. Ketoprofen 300 mg/day. Tramadol as rescue analgesia	Not reported

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

Celidonio 2008	Continuous femoral nerve block with 20 mL 0.5% ropivacaine 3 mg/kg (maximum 40 mL), sufentanil and clonidine alone or associated with single injection sciatic nerve block with 20 mL of the same solution. Infusion of 0.2% ropivacaine and sufentanil at 8 mL/hour through the femoral nerve catheter for 48 hours. Continuous lumbar epidural with 0.5% ropivacaine 15 mL to 20 mL and sufentanil, clonidine. Infusion of 0.2% ropivacaine and sufentanil at 8 mL/hour through the epidural catheter for 48 hours	Not reported	Morphine and ketorolac	Not reported
Chen 2015	Continuous femoral nerve block (puncture site below the inguinal ligament and outside the femoral artery) with catheter inserted 10 cm past the needle tip connected to a patient-controlled pump for 72 hours	Not reported	Not reported	Not reported
Cucoreanu Badi-ca 2010	Fascia iliaca compartment block with 40 mL 0.5% ropivacaine. Spinal anaesthesia with 0.5% bupivacaine for surgery	No significant adverse effects	IV morphine	Not reported
Duarte 2009	All blocks performed on the operated side in the upper position. Psoas compartment block (Capdevila 2002) with a nerve stimulator and 0.4 mL/kg 0.5% ropivacaine injected when a quadriceps contraction was obtained between 0.35 and 0.5 mA and 50 ms. Catheter inserted after the initial bolus (20 G multi-orifice) inserted 3 cm to 5 cm cephalad. Patient-controlled continuous block after the surgery with ropivacaine 0.2%. Epidural catheter with a paramedian approach at L3-L4 or L4-L5 with 10 mL to 15 mL 0.5% ropivacaine before catheter insertion (20 G multi-orifice; inserted 3 cm to 5 cm cephalad). Patient-controlled continuous epidural analgesia after the surgery with ropivacaine 0.2% and fentanyl 3 µg/mL	Not reported	IV morphine	Not reported
Forget 2009	Single injection fascia iliaca (landmarks) with 0.4 mL/kg 0.5% L-bupivacaine (max 30 mL) with clonidine 2.5 µg/mL and epinephrine 5 µg/mL. Single injection epidural analgesia (iliac crest level) with 10 mL 0.25% L-bupivacaine and 10 µg sufentanil	Partial transient motor blockade for 4 participants. Side effects and complications similar for both groups	IV paracetamol 1 g every 6 hours. IV patient-controlled pir- itramide	Side effects and complications similar for both groups
Fouad 2010	Continuous psoas compartment block with dual guidance (ultrasound (in-plane) and nerve stimulator), catheter insertion, 25 mL 0.375% ropivacaine.	Not reported	IV flurbiprofen 50 mg every 12 hours. Pentazocine	Not reported

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

	<p>Continuous infusion of 0.2% ropivacaine at 4 to 6 mL/h.</p> <p>Continuous epidural analgesia with 6 mL ropivacaine 0.5% plus fentanyl 100 µg continuous infusion with 0.2% ropivacaine and fentanyl 4 µg/mL at 4 to 6 mL/h</p>			
Fournier 1998	<p>Femoral nerve block (Winnie 1973) with nerve stimulation and 40 mL 0.5% bupivacaine with epinephrine 5 µg/mL injected when a quadriceps contraction was obtained at ≤ 0.4 mA (needle angled proximally).</p> <p>Sham block</p>	<p>No side effects such as paraesthesiae or dysaesthesiae in the area covered by the block, haematoma or signs of infection were observed</p>	<p>IM diclofenac and/or subcutaneous morphine 0.1 mg/kg</p>	<p>Not reported</p>
Frassanito 2008	<p>Operated side upper position.</p> <p>Psoas compartment block (Capdevila 2002) with a nerve stimulator and 0.4 mL/kg ropivacaine 0.5% injected when a quadriceps contraction was obtained at 0.5 mA and 0.1 ms.</p> <p>Spinal anaesthesia (L3-L4) with 15 mg hyperbaric bupivacaine plus 15 µg fentanyl and 0.1 mg morphine</p>	<p>One epidural extension.</p> <p>No failed spinal or psoas compartment block</p>	<p>Intrathecal morphine 0.1 mg.</p> <p>Routine paracetamol 1 g IV 4 x daily and ketorolac 30 mg IV 3 x daily.</p> <p>IV tramadol as rescue</p>	<p>No respiratory depression.</p> <p>Higher risk of pruritus with intrathecal morphine</p>
Fredrickson 2015	<p>Continuous psoas compartment block (Heller 2009) with a nerve stimulator, catheter inserted 3 cm past the needle tip and needle bevel oriented laterally when a quadriceps contraction was obtained between 0.5 and 0.8 mA and 0.1 ms and loaded with 40 mL 0.5% ropivacaine followed by patient-controlled analgesia with 0.2% ropivacaine after surgery.</p> <p>Spinal anaesthesia with 2 mL 0.5% and morphine 0.1 mg</p>	<p>Neurological irritation or injury did not differ between groups.</p> <p>Symptoms suggestive of neurological irritation or injury did not differ (spinal = 8/23 and psoas compartment block = 6/27) between groups. All were mild and short-lived.</p> <p>No participant demonstrated symptoms or signs of systemic local anaesthetic toxicity and there were no catheter-related bleeding or infectious complications</p>	<p>Intrathecal morphine 0.1 mg.</p> <p>IV parecoxib 40 mg at the time of surgery.</p> <p>Oral paracetamol 1 g every 6 hours.</p> <p>Sustained release diclofenac 75 mg every 12 hours.</p> <p>Sustained release tramadol 100 mg every 12 hours on request.</p> <p>Oral or IV morphine as rescue analgesia.</p> <p>(Lumbar plexus group participants also received morphine 0.1 mg/kg IV during surgery)</p>	<p>Higher risk of pruritus in the intrathecal group.</p> <p>2 in-hospital falls with intrathecal morphine</p>

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

Gelmanas 2010	Continuous psoas compartment block with bupivacaine 0.125% and fentanyl 0.05 mg/mL at 5 to 10 mL/hour. Continuous epidural analgesia with bupivacaine 0.125% and fentanyl 0.05 mg/mL at 3 to 5 mL/hour	Degree of motor block was significantly higher in the lumbar plexus block group	Type of additional analgesic used unspecified	Frequency of side effects did not differ significantly between groups
Ginz 2000	Obturator nerve block (obturator canal level) with a nerve stimulator and 30 mL 0.25% bupivacaine injected when an adductor muscle contraction was obtained at 0.5 mA	Not reported	IV piritramide on request. Rectal diclofenac 100 mg or metamizole 1 g on request	Not reported
Goytizolo 2016	Lumbar plexus block with a nerve stimulator and 30 mL 0.5% bupivacaine injected when a quadriceps contraction was obtained < 1 mA. Combined spinal/epidural with 60 mg 1.5% mepivacaine and 3 mL aliquots of 2% lidocaine through an epidural catheter for surgery and patient-controlled epidural analgesia with 0.06% bupivacaine and 10 µg/mL hydromorphone for postoperative analgesia for all participants	No adverse events attributable to the lumbar plexus block occurred	Epidural patient-controlled analgesia and oral opioid	No adverse events attributable to either technique occurred
Green 2014	The psoas compartment block (50 mL (40 mL 0.25% bupivacaine and 10 mL saline) was administered using an 18 G spinal needle. volume of (Green 2011). Spinal anaesthesia for surgery	There were no adverse events peri-operatively, directly related to block administration	Routine paracetamol 1 g 4 x daily and diclofenac 75 mg 2 x daily. Oxycontin 10 mg 2 x daily. Oxynorm for breakthrough pain as required on a 4 hourly basis	Not reported
Jensen 2012	Femoral, obturator (anterior branch) and lateral femoral cutaneous nerve block	Not reported	Morphine on request	Not reported
Kai 2010	Psoas compartment block with a nerve stimulator with 30 mL 0.375% ropivacaine injected when a quadriceps contraction was obtained at 0.3 mA and isobaric spinal anaesthesia (L2-L3 or L3-L4) with bupivacaine 0.12 mg/kg. Epidural (L2-L3 or L3-L4) and isobaric spinal anaesthesia (L2-L3 or L3-L4) with bupivacaine 0.16 mg/kg for surgery	No participants had post-dural puncture headache or back pain	Not reported	All participants had oxygen saturation between 98% and 100%
Kearns 2011	Ultrasound-guided (out-of-plane) fascia iliaca block with levobupivacaine 2 mg/kg diluted to a total volume of 40 mL below the inguinal ligament but proximal to any femoral artery branching	4 adverse events defined as any untoward medical occurrence and 4 serious adverse events defined as result-	Intrathecal morphine 0.1 mg. IV patient-controlled analgesia with morphine	3 adverse events defined as any untoward medical occurrence and 2 serious adverse events de-

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

		ing in death or life threatening (at the time of the event) or required hospitalization or prolongation of existing hospitalization or resulting in persistent or significant disability or incapacity or consisting of a congenital anomaly or birth defect or being otherwise considered medically significant by the investigator (not necessarily related to the trial treatment).		fining as resulting in death or life threatening (at the time of the event) or required hospitalization or prolongation of existing hospitalization or resulting in persistent or significant disability or incapacity or consisting of a congenital anomaly or birth defect or being otherwise considered medically significant by the investigator (not necessarily related to the trial treatment).
		Pulmonary embolism (N = 2), femoral nerve palsy (N = 1; resolved at 3 months), late wound infection (N = 1)		Pulmonary embolism (N = 1), wound infection resulting in multi-organ failure (N = 1)
Köroğlu 2008	Femoral (3-in-1) block with nerve stimulation and 40 mL 0.25% bupivacaine injected when a quadriceps contraction was obtained at 0.5 mA and with distal pressure	There was no local anaesthetic toxicity	IV patient-controlled analgesia with tramadol	Most common side effects were nausea and vomiting
Kratz 2015	Single injection femoral nerve block with a nerve stimulator and 20 mL 0.25% bupivacaine with 20 µg clonidine injected when a quadriceps contraction was obtained at 0.4 mA and 0.1 ms	Not reported	Metamixol 15 to 25 mg/kg before end of surgery. IV piritramide (in the postoperative care unit). Ibuprofene. Metamizole. Oral oxycodone	Not reported
Lončar 2016	Single injection femoral nerve or fascia iliaca block	Not reported	IV morphine	Not reported
Marino 2009	Continuous psoas compartment block with nerve stimulator, catheter advanced 3 cm past the needle tip when a quadriceps contraction was obtained at 0.5 mA and 100 ms. Catheters were loaded with 0.6 mL/kg ropivacaine 0.5% and the position was verified with 10 mL contrast medium. Participants then received ropi-	Lumbar plexus block was associated with an epidural spread in 5/75 (7%) participants. Postoperatively, two lumbar plexus	IV patient-controlled analgesia with hydromorphone	Nausea and pruritus

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

	<p>vacaine 0.2% infused at 0.15 mL/kg/hour for 48 hours.</p> <p>Continuous femoral nerve block loaded through the needle with 0.6 mL/kg ropivacaine 0.5% injected when a quadriceps contraction was obtained at 0.5 mA and 100 ms, catheter advanced < 10 cm past the needle tip. This was followed by an infusion of ropivacaine 0.2% at 0.15 mL/kg/hour for 48 hours</p>	<p>catheters (3%) clotted compared to no femoral catheters. 2/75 femoral catheters were found to be ineffective postoperatively; the total failure rate for both the lumbar plexus and femoral catheters was 3%. There was no evidence of any untoward neurologic sequelae or local anaesthetic toxicity in either of the catheter groups.</p> <p>No perineural haematoma recorded</p>		
Marshall 2008	<p>Continuous lumbar plexus block as patient-controlled analgesia.</p> <p>Continuous epidural analgesia.</p> <p>Spinal anaesthesia for surgery</p>	Not reported	Parenteral opioids	Not reported
Murray 2005	<p>Fascia iliaca block on landmarks with 2 mg/kg 0.5% levobupivacaine.</p> <p>Spinal anaesthesia with isobaric 0.5% bupivacaine 0.1 to 0.2 mg/kg for surgery</p>	Not reported	IV patient-controlled analgesia with morphine	Not reported
Nicholson 2002	Femoral (3-in-1) nerve block with a nerve stimulator and 30 mL of equal parts 0.5% bupivacaine and 2% lidocaine	Not reported	<p>Routine paracetamol 1 g every 6 h.</p> <p>Diclofenac 8 mg on request.</p> <p>IM morphine</p>	Not reported
Nishio 2014	Dual guidance continuous femoral nerve block (ultrasound and nerve stimulator) with a catheter inserted 10 cm past the needle tip and participants received an infusion of 0.15% ropivacaine at 3 mL/hour	Not reported	<p>IV patient-controlled analgesia with fentanyl or intrarectal diclofenac or IV flurbiprofen on participant's request and preferences</p>	Nausea and vomiting, drowsiness
Saksena Shrivastava 2011	Continuous femoral nerve block with 0.1 mL/kg/hour of 0.1% bupivacaine.	Not reported	IV patient-controlled analgesia with fentanyl	Not reported

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

Continuous epidural analgesia with 0.1 mL/kg/hour 0.1% bupivacaine

Shariat 2013	Ultrasound-guided (in-plane), low pressure (20 pounds per square inch) fascia iliaca block with 30 mL 0.5% ropivacaine	Not reported	IV patient-controlled analgesia with morphine	Not reported
Siddiqui 2007	Continuous psoas compartment block (Winnie 1974) with a nerve stimulator and a 4 inch Tuohy needle (quadriceps contraction at 0.5 to 1.0 mA and 50 ms) and 5 mL saline before catheter insertion advanced 4 cm to 6 cm past the needle tip. Injection of 3 mL 2% lidocaine with epinephrine 5 µg/mL followed by 20 mL 0.25% bupivacaine and an infusion of 0.125% bupivacaine at 10 mL/hour for 36 hours	One participant in the continuous lumbar plexus block developed a delayed paresis (first noted 4 weeks after surgery), possibly related to nerve compression by a haematoma, international normalized ratio 5.6 on postoperative day 3. The weakness improved but remained at 3 months	IV patient-controlled analgesia with morphine	One participant in the systemic analgesia group developed respiratory depression
Singelyn 2005	Continuous femoral nerve block (Winnie 1973) with a nerve stimulator and 40 mL 0.25% bupivacaine with epinephrine 5 µg/mL through a catheter inserted 10 cm past the needle tip followed by an infusion of 0.125% bupivacaine at 10 mL/hour. Epidural analgesia at L2-L3 or L3-L4 with catheters inserted 4 cm to 5 cm past the needle tip, a test dose with 3 mL 0.25% bupivacaine with epinephrine 5 µg/mL, followed by 10 mL of the same solution and 10 µg sufentanil and then by an infusion of 0.125% bupivacaine at 10 mL/hour	3 participants with catheter-related problems in the epidural group 2 urinary retention for femoral nerve block group and 6 for epidural group	IV patient-controlled analgesia with morphine	4 urinary retention in the IV morphine group
Souron 2003	Psoas compartment block (Winnie 1975) with a nerve stimulator and with 25 mL ropivacaine 0.475% injected when a quadriceps contraction was obtained at 0.5 mA and 0.1 ms	No major complication occurred. Epidural block did not occur. 2 blood aspirations during psoas compartment block performance	Intrathecal morphine 0.1 mg	No major complications were observed with either technique
Stevens 2000	Psoas compartment block (Winnie 1974) with a nerve stimulator and 0.4 mL/kg 0.5% bupivacaine and epinephrine 5 µg/mL injected when a quadriceps contraction was obtained between 0.2 and 0.5 mA and 50 ms	Epidural anaesthesia occurred in 3 of 28 plexus group participants No other side effects were noted, total spinal anaesthesia, renal	IV patient-controlled analgesia with morphine	Nausea and vomiting

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

		subcapsular haematoma, and psoas haematoma with lumbar plexopathy were not observed in this trial		
Stevens 2007	<p>Fascia iliaca block with modified landmarks (Dalens 1989 but 1 cm above the inguinal ligament; first pop when the needle traverses the superficial fascia and second pop for the fascia transversalis) and 30 mL 0.5% bupivacaine with epinephrine 5 µg/mL, 150 µg of clonidine and 9 mL saline.</p> <p>Hypothesis: this puncture point would enable blockade of the ilio-inguinal, iliohypogastric and genitofemoral nerves as well as the femoral, lateral cutaneous and obturator nerves but sensory block not tested</p>	Not reported	IV patient-controlled analgesia with morphine	Nausea and vomiting
Striebel 1993	<p>Continuous femoral (3-in-1) nerve block with catheters (inserted 10 cm past the needle tip) with a nerve stimulator (between 0.2 and 2.0 mA on needle) and 30 mL 0.5% bupivacaine administered before surgery (quadriceps motor blockade confirmed before anaesthesia induction) and 10 minutes after surgery</p>	<p>Mean bupivacaine plasma levels ranged between 0.75 and 1.33 µg/mL</p> <p>Placement of the 3-in-1 catheters were without complications</p>	IV meperidine on request	Nausea and vomiting
Thomas 2009	Continuous femoral nerve block with lidocaine (lidocaine 1% bolus followed by intra-operative infusion of lidocaine 1% 10 mL/hour and lidocaine 0.5% 10 mL/hour during 24 hours postoperatively)	Not reported	<p>IV lidocaine infusion: 1.5 mg/kg followed by intra-operative continuous infusion of 2 mg/kg/hour and post-operatively 1 mg/kg/hour for 24 hours.</p> <p>All participants received paracetamol 4 g for 24 hours and IV patient-controlled analgesia with morphine</p>	Not reported
Thybo 2016	<p>Ultrasound-guided (in-plane) lateral femoral cutaneous nerve block with 8 mL 0.75% ropivacaine.</p> <p>Spinal anaesthesia with 2 mL to 2.5 mL 0.5% isobaric bupivacaine for surgery</p>	No adverse events or harms were observed during the trial	<p>Paracetamol 1 g orally every 6 hours.</p> <p>Ibuprofen 600 mg orally every 8 hours.</p>	No adverse events, or harms, were observed during the trial

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

			IV or oral oxycodone on request	
Türker 2003	<p>Psoas compartment block (side to blocked up-permost, 3 cm caudal and 5 cm lateral to L4 apophysis and redirected upward if the apophysis of L5 was contacted) with a nerve stimulator and when a quadriceps contraction was obtained at 0.5 mA, 10 mL saline was injected before catheter insertion 5 cm past the needle tip. This was followed by a test dose with 3 mL 2% lidocaine with epinephrine 5 µg/mL, then 20 mL contrast solution, followed by 30 mL 0.5% bupivacaine (repeated if surgery lasted > 2 hours).</p> <p>Patient-controlled analgesia with 0.125% bupivacaine and fentanyl 2 µg/mL for 24 hours.</p> <p>Epidural analgesia at L3-L4, catheters advanced 3 cm cephalad, test dose with 3 mL 2% lidocaine with epinephrine 5 µg/mL followed by 15 mL 0.5% bupivacaine (repeated if surgery lasted > 2 hours).</p> <p>Patient-controlled analgesia with 0.125% bupivacaine and fentanyl 2 µg/mL for 24 hours</p>	<p>Psoas: 2 kinked catheters</p> <p>No participants in the psoas group developed epidural extension.</p> <p>Epidural: 1 kinked catheter and 1 lateralization on non-operated side.</p> <p>No participants in either group developed complications such as cardiac arrest, permanent paraesthesia or paralysis, infection or haematoma at the injection site, or deep vein thrombosis.</p> <p>7 urinary retention in the epidural group</p>	IM diclofenac 75 mg on request	<p>Nausea and vomiting</p> <p>Pruritus</p>
Twyman 1990	<p>Psoas compartment block (Chayen 1976), loss of resistance technique, 20 mL air injected to dilate the space followed by 0.42 mL/kg of 0.375% bupivacaine</p>	<p>There were no complications associated with the technique</p>	Unspecified	Not reported
Uhrbrand 1992	<p>Femoral (3-in-1; Brands 1978) nerve block with a nerve stimulator and 20 mL 0.5% bupivacaine plus 20 mL 2% lidocaine with epinephrine</p> <p>Femoral lateral cutaneous nerve block with 5 mL 1% lidocaine on landmarks</p>	<p>One haematoma in the groin after accidental puncture of the femoral artery</p> <p>No toxic reactions due to the local anaesthetics were recorded</p>	Nicomorphine on request	Not reported
Utebey 2009	<p>Continuous psoas compartment block with a nerve stimulator (Parkinson's approach; Parkinson 1989; L3 confirmation with fluoroscopy in prone position) and with 0.4 mL/kg 0.25% bupivacaine injected before surgery when a quadriceps contraction was obtained at 0.5 mA (position confirmed with 2 mL radiopaque substance and catheter inserted 2 cm past the needle tip) and half dose after 8 hours.</p> <p>Continuous lumbar (L3-L4; catheters threaded 3 to 3.5 cm cranially) epidural analgesia with a test dose (3 mL 2% lidocaine) and 2 mL per segment</p>	<p>Two epidural spreads</p> <p>One urinary retention with epidural analgesia</p>	IV patient-controlled analgesia with morphine	Pruritus

Table 1. Details of nerve blocks and complications related to analgesic techniques (Continued)

until T10-T12 before general anaesthesia with 0.025% bupivacaine and half dose after 8 hours				
Van Herreweghe 2015	Supra-inguinal fascia iliaca compartment block with 40 mL 0.5% ropivacaine	Not reported	Paracetamol Non steroidal anti-inflammatory drugs IV patient-controlled analgesia with morphine	Not reported
Wiesmann 2014	Femoral nerve block with a nerve stimulator and 15 mL bupivacaine 0.25% and clonidine 20 µg injected when a quadriceps contraction was obtained at 0.3 mA and 0.1 ms	Not reported	IV piritramide in the postoperative care unit. IV/oral metamizole and oral ibuprofen in both groups on request	No oxygen saturation < 90% No nausea and vomiting

IM: intramuscular; IV: intravenous; mA: milliampere; ms: millisecond;

APPENDICES

Appendix 1. CENTRAL (the Cochrane Library) search strategy

#1 MeSH descriptor: [Arthroplasty, Replacement, Hip] explode all trees
#2 hip* near (replac* or operat* or surg* or arthroplast*)
#3 #1 or #2
#4 MeSH descriptor: [Anesthetics, Local] explode all trees
#5 MeSH descriptor: [Nerve Block] explode all trees
#6 MeSH descriptor: [Anesthesia, Local] explode all trees
#7 MeSH descriptor: [Anesthesia, Epidural] explode all trees
#8 ((nerve near block*) or (an?est* near (local or regional))):ti,ab
#9 #4 or #5 or #6 or #7 or #8
#10 #3 and #9

Appendix 2. MEDLINE search strategy

1 exp Arthroplasty, Replacement, Hip/ or (hip* adj5 (replac* or operat* or surg* or arthroplast*)).af.
2 exp Anesthetics, Local/ or exp Nerve Block/ or exp Anesthesia, Local/ or (nerve adj3 block*).mp. or Anesthesia, Epidural/ or (an?est* adj3 (local or regional)).mp.
3 1 and 2
4 ((randomized controlled trial or controlled clinical trial).pt. or randomized.ab. or placebo.ab. or drug therapy.fs. or randomly.ab. or trial.ab. or groups.ab.) not (animals not (humans and animals)).sh.
5 3 and 4

Appendix 3. Embase (Ovid SP) search strategy

1. exp hip arthroplasty/ or (hip* adj5 (replac* or operat* or surg* or arthroplast*)).af.
2. exp local anesthetic agent/ or exp nerve block/ or exp local anesthesia/ or (nerve adj3 block*).mp. or epidural anesthesia/ or (an?est* adj3 (local or regional)).mp.
3. (randomized-controlled-trial/ or randomization/ or controlled-study/ or multicenter-study/ or phase-3-clinical-trial/ or phase-4-clinical-trial/ or double-blind-procedure/ or single-blind-procedure/ or (random* or cross?over* or multicenter* or factorial* or placebo* or

volunteer*).mp. or ((singl* or doubl* or trebl* or tripl*) adj3 (blind* or mask*)).ti,ab. or (latin adj square).mp.) not (animals not (humans and animals)).sh.

4. 1 and 2 and 3

Appendix 4. CINAHL (EBSCO) search strategy

S1 MM "Arthroplasty, Replacement, Hip" OR (hip* N5 (replac* or operat* or surg* or arthroplast*))

S2 ((MH "Anesthetics, Local+") OR (MH "Nerve Block+") OR (MH "Anesthesia, Local") OR (MH "Anesthesia, Epidural")) OR nerve N3 block* OR (an?est* N3 (local or regional))

S3 (random* or placebo* or prospective or multicent* or (trial* N3 (clinical or controlled))) or ((blind* or mask*) N3 (single or double or triple or treble))

S4 S12 and S2 and S3

Appendix 5. ISI Web of Science search strategy

#1 TS=(hip* SAME (replac* or operat* or surg* or arthroplast*))

#2 TS=(nerve SAME block*) or TS=(an?est* SAME (local or regional))

#3 TS=(random* or placebo* or prospective or multicent* or (trial* and (clinical or controlled)) or ((blind* or mask*) and (single or double or triple or treble)))

#4 #3 AND #2 AND #1

Appendix 6. Scopus search strategy

Hip AND (replac* OR arthroplasty OR operat* OR surg*) AND (nerve block OR compartment block OR fascia iliaca OR three-in-one OR 3-in-1)

Appendix 7. Risk of bias assessment

Random sequence generation (selection bias):

We considered allocation sequence generation low risk if it was generated using a computer or random number table algorithm. Other methods were rated as at low risk if the entire sequence was generated before starting the trial.

Allocation concealment (selection bias):

We considered allocation concealment low risk if the participant recruiters, investigators, and participants were unable to anticipate treatment assignment. Adequate methods included a central allocation system (telephone, web-based or pharmacy-controlled randomization) or sequentially numbered, sealed, opaque envelopes.

Blinding (performance and detection bias):

We considered blinding low risk if:

- the participants and personnel (healthcare providers) were blinded to the allocated intervention, and it was unlikely that the blinding could have been broken;
- the outcome assessors were blinded to the allocated intervention, and it was unlikely that the blinding could have been broken.

We considered blinding high risk if:

- the blinding of the participants and personnel was attempted, but it was likely that the blinding could have been broken, and the outcome was likely to be influenced by the lack of blinding;
- no blinding or incomplete blinding, and the outcome is likely to be influenced by the lack of blinding;
- the outcome assessors were blinded, but it was likely that the blinding could have been broken;
- the outcome assessors were not blinded.

Incomplete outcome data (attrition bias):

We considered a study as having low risk of incomplete outcome data if:

- there was no missing outcome data;
- the proportion of missing outcomes compared with observed event risk was not enough to have a clinically relevant impact on the intervention effect estimate, i.e. the percentage of missing data was small;
- the reasons for missing outcome data are unlikely to be related to true outcome, and the percentage of missing data is small;
- the missing outcome data were balanced in numbers across intervention groups with similar reasons for missing data across groups;
- the missing data have been imputed appropriately.

We considered a study as having high risk of incomplete outcome data if:

- the reasons for missing outcome data were likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups;
- the proportion of missing outcomes compared to observed event risk was enough to induce clinically relevant bias in the intervention effect estimate;
- 'as treated' analysis was done with substantial departure of the intervention received from that assigned at randomization;
- there was potentially inappropriate application of simple imputation.

Selective reporting (reporting bias):

We considered a study as having low risk of selective reporting if all the study's a priori outcomes at interest in the review were reported in the prespecified way.

We considered a study as having high risk of selective reporting for any of the following.

- Not all of the study's a priori outcomes were reported.
- One or more primary outcomes were only reported using measurements, analysis methods, or subsets of data that were not prespecified.
- One or more reported primary outcomes were not prespecified, unless clear justification of their reporting was provided.
- One or more outcomes of interest in the review were reported incompletely such that they could not be included in a meta-analysis.

CONTRIBUTIONS OF AUTHORS

Joanne Guay (JG), Rebecca Lee Johnson (RLJ) and Sandra L Kopp (SK)

Conceiving the review: only JG was member of the team who wrote the protocol

Co-ordinating the review: JG

Undertaking manual searches: JG

Screening search results: JG and RLJ

Organizing retrieval of papers: JG

Screening retrieved papers against inclusion criteria: JG, RLJ and SK

Appraising quality of papers: JG and SK

Abstracting data from papers: JG and SK

Writing to authors of papers for additional information: JG

Providing additional data about papers: JG

Obtaining and screening data on unpublished studies: JG

Data management for the review: JG

Entering data into Review Manager (RevMan 5.3): JG

RevMan statistical data: JG

Other statistical analysis not using RevMan: JG

Interpretation of data: JG, RLJ and SK

Statistical inferences: JG

Writing the review: JG, RLJ and SK

Securing funding for the review: departmental resources only

Guarantor for the review (one author): JG

Person responsible for reading and checking review before submission: JG, RLJ and SK

DECLARATIONS OF INTEREST

Joanne Guay: none known.

Rebecca L Johnson: is contact author for a trial awaiting classification that may fit inclusion criteria ([NCT02242201](#)).

Sandra Kopp: none known.

SOURCES OF SUPPORT

Internal sources

- Université du Québec en Abitibi-Témiscamingue, Canada.
provided access to electronic databases and major medical journals
- University of Sherbrooke, Canada.
granted access to electronic databases and major medical journals

External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We made the following changes from the published protocol ([Kalore 2015](#)).

Types of interventions

Primary interventions

1. Intervention

Protocol stated: "We will include peripheral nerve blocks (such as the lumbar plexus/psoas compartment block, femoral nerve block, and fascia iliaca compartment block) versus no nerve blocks." In the Review we included all peripheral nerve blocks: "We included all peripheral nerve blocks: psoas compartment block, femoral nerve block (or 3-in-1) block, fascia iliaca compartment block, obturator nerve block or femoral lateral cutaneous nerve block as the intervention." We thought that these blocks were simply forgotten when the protocol was written and wanted to be in accordance with the title of the review.

2. Comparator

The comparator was not clearly described in the protocol. In the Review we proposed: "For comparators we divided studies according to systemic analgesia, no block or sham block (comparison 1), neuraxial blocks (comparison 2), local anaesthetic infiltration (comparison 3) or intravenous lidocaine infusion (comparison 4)".

Outcomes

Follow-up for neurological damage

In the protocol we stated that complications lasting more than one month would be considered. This was changed in the Review to "lasting more than three months."

Two lasting neurological complications were reported. Results were not available after one month of follow-up but were available for two participants after three months follow-up. Therefore, we chose two modify the outcome. We are not aware of any universally-accepted definition of 'lasting neurological complication'. We felt that adopting three months (as applied in some trials, such as [Auroy 1997](#)) seemed reasonable.

Minimal clinically important improvement in pain

Protocol stated: "We will evaluate if the improvement in pain scores (continuous variable) was clinically important (categorical variable). We will consider a pain scale improvement of 2 cm with nerve block on a 0 cm to 10 cm VAS scale as clinically important. We will assess the proportion of participants with pain VAS scale differences of 2 cm on a 0 cm to 10 cm scale as categorical variable".

Review: None of the included trials reported this outcome as a categorical variable. Results were provided as time points at which pooled results demonstrated an effect equivalent to 2 or more on a scale of 0 to 10.

Search

We included a search of Scopus that was not proposed in the protocol.

Risk of bias assessment

This was presented as [Appendix 7](#). We removed: "However, we note that it is challenging to truly blind participants and personnel, as this would require the insertion of the epidural or femoral catheters in all participants, which might be considered unethical and inappropriately invasive" because some of the trials included a sham block and we considered that it would have been inappropriate for us to judge those trials as "unethical and inappropriately invasive" for this reason.

Measurement of treatment effect

We added "For results given as SMD, we calculated a clinical equivalence on a known scale by multiplying the SMD by a typical standard deviation (SD) of one of the studies included in the analysis."

Unit of analysis issues

Protocol: "Some trials may compare multiple interventions or control groups of interest. Where each arm assesses a different intervention of interest, we will analyse the interventions separately in the appropriate meta-analysis. To address issues of double-counting and unit-of-analysis error of the control group resulting from including several correlated comparisons in a meta-analysis, we will split the control group into two groups (shared) with smaller size and included will include two reasonably independent comparisons. We are motivated in our choice of analysis by the fact that we are employing random-effects method meta-analysis, and this approach enables approximate investigation of heterogeneity across intervention arms. Nevertheless, we will consider the following two approaches for sensitivity analysis:

1. include two or more correlated comparisons and account for the correlation; and
2. combine groups to create a single pair-wise comparison as recommended in the *Cochrane Handbook for Systematic*

Reviews of Interventions ([Higgins 2011](#))."

Review: "Some trials compared multiple interventions or control groups of interest. Where each arm assessed a different intervention of interest, we analysed the interventions separately in the appropriate meta-analysis. To address issues of double-counting and unit-of-analysis error of the control group resulting from including several correlated comparisons in a meta-analysis, we: 1. excluded a subgroup not relevant to the review, 2. split the control group into two groups (shared) with smaller size and included two reasonably independent comparisons or 3. combined two subgroups and included only one comparison. We chose to split a subgroup when we thought that it would help our heterogeneity exploration without adding the risk of introducing a small-study effect."

Although this was not a change per se, we think that it is more clearly written as it is now in the review.

Dealing with missing data

Protocol: "We will contact authors if any required data are missing. We will use the Review Manager 5.3 (RevMan 5.3) calculator to calculate the missing data from other relevant statistics reported in the article (that is standard deviations (SD) from standard error (SE) using the formula $SE = SD/\sqrt{n}$, estimate range from 95% confidence interval, estimate mean from median). If these statistics are not reported, then we will impute the missing data according to the recommendations in Chapter 16 of the *Cochrane Handbook for Systematic Reviews of Interventions* ([Higgins 2011](#)). For data assumed not missing at random, we will impute the missing data assuming the best and worst-case scenarios and conduct sensitivity analyses to assess how sensitive the results are to the change in the assumptions that are made."

Review: "All study authors were contacted. Standard deviations were calculated from standard errors of the mean but not from quartiles or ranges. Medians were not considered equivalent to means. Data given as exact P values were extracted as such. We made no imputations."

Assessment of heterogeneity

Protocol: "We will present primary analyses using the random-effects model and discuss the results of other models in sensitivity analyses. We will assess statistical heterogeneity using the χ^2 test for heterogeneity and quantify heterogeneity using the I^2 statistic ([Higgins 2011](#)). We will consider values of I^2 greater than 50% to represent significant between-study heterogeneity ([Higgins 2003](#)). If significant heterogeneity exists, we will explore the data and test whether our planned subgroup analyses explain the heterogeneity. We will explore possible interactions between the effect of nerve blocks and variables using planned subgroup analyses."

Review: "We presented primary analyses using fixed- ($I^2 < 25\%$) or random-effects ($I^2 \geq 25\%$) models. We considered values of $I^2 > 25\%$ to represent significant between-study heterogeneity ([Higgins 2003](#)). If significant heterogeneity existed ($> 25\%$), we assessed data according to our predefined criteria for heterogeneity exploration with meta-regression or subgrouping as appropriate. We also used sensitivity analysis based on risk of bias or presence of an outlier. When possible (≥ 3 studies) we tested results for the possibility of a small-study effect using Egger's regression intercept ([Egger 1997](#))."

Following examination of forest plots for results presenting more than low level heterogeneity ($I^2 > 25\%$), we retained the following factors for heterogeneity exploration: participants' age, type of nerve block, type of local anaesthetic used, volume, concentration and dose of local anaesthetic (in lidocaine equivalent) used as loading dose, block administration duration (single injection versus continuous block for the intervention, the comparator or both) and comparator.

Assessment of reporting biases

Protocol: "If there are a sufficient number of included trials (10 or more), we will generate funnel plots of the size of the treatment effect against the precision of the trial (1/standard error) to assess for publication bias. Should asymmetry exist, we will use the 'trim and fill' method described by [Sutton 2000](#) to calculate an adjusted overall confidence interval. Since there are also other reasons for an asymmetric funnel plot, we will look for evidence of poor methodological quality of poor studies, true heterogeneity, or chance as possible causes ([Egger 1997](#)).

We will use Orwin's fail-safe N test to evaluate the impact of potential publication bias on the robustness of the overall observed effect ([Orwin 1983](#)). We will determine how many missing studies would render a significant overall effect non significant or trivial as defined by the following:

Outcome	Effect in missing studies	Cumulative effect
Change (or raw) scores based on SMD	0	0.001
Binary outcome based on risk ratio	1	1.05

Review: We assessed publication bias (three studies or more) with funnel plots followed by Duval and Tweedie's trim and fill technique ([Duval 2000](#); [Duval 2000a](#)).

Data synthesis

Protocol: "We will conduct meta-analysis using Review Manager 5.3 ([Review Manager 2014](#)) when there are sufficient data from two or more trials. We will use the random-effects model of DerSimonian and Laird, as we anticipate that heterogeneity will be present in interventions and outcomes ([DerSimonian 1986](#)).

We will combine pain VAS (primary outcome) results that sampled different parts of the scale using SMDs. In the event that dichotomous data for opioid consumption are not available, we will synthesize the means of opioid consumption using SMDs. Where it was not possible to conduct meta-analysis, we presented will present the data in a table format and discuss the results as a narrative review."

Review: "We conducted meta-analysis using Review Manager 5.3 ([Review Manager 2014](#)) when there were sufficient data from two or more trials. We used fixed- ($I^2 < 25\%$) or random-effects models ([Higgins 2003](#)) and presented data as RR, RD, MD or SMD according to review criteria ([Measures of treatment effect](#)). When a result was considered positive using a fixed-effect model, we also analysed results using random-effects models to ensure that conclusions were not affected by the type of model used (fixed- versus random-effects).

Where it was not possible to conduct meta-analysis, we presented data narratively."

Sensitivity analysis

Protocol: "Protocol: "We will perform sensitivity analyses to evaluate the effect on the overall result of removing trials with low and unclear methodological quality. In the case of a high percentage of missing data, we will also conduct sensitivity analysis to determine the effect of the imputation of missing data. If there are multiple intervention groups within a study, we will consider the following two approaches for sensitivity analysis:

1. include two or more correlated comparisons and account for the correlation; and
2. combine groups to create a single pair-wise comparison as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* ([Higgins 2011](#)).

The first approach to sensitivity analysis involves calculating a weighted average of the relevant pair-wise comparisons from the studies in question and calculating a variance for the study taking into account the correlation between the comparisons. The correlation is estimated based on the number of cases in each group ([Borenstein 2009](#)) as follows: $P = 2 (N_{\text{control}})/(N_{\text{study}} + N_{\text{control}})$, where N_{control} is the size of the control group and N_{study} is the sample size of the

study. For equal group sizes $P = 0.5$ and approaches 1 (0) as the size of the control group approaches the sample size of the study (zero). We will combine multiple control groups within a study to form a single composite control group for the study. Group combinations will lead to a single pair-wise comparison within studies, as recommended in Chapter 16 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011)."

Review: "We performed sensitivity analyses based mainly on the risk bias assessment and presence of outliers."

Summary of findings tables

Protocol: "We will use the principles of the GRADE system (Guyatt 2008) to assess the quality of the body of evidence associated with specific outcomes (as listed below) in our review, and construct a 'Summary of findings' table using the GRADEpro software:

- Patient reported pain at rest and with movement
- Total number of nerve block-related complications
- Complications specific to method of treatment, particularly neurologic injury
- Analgesic requirements
- General medical complications, particularly nausea and vomiting
- Patient satisfaction
- Short-term rehabilitation milestones like time to discontinue gait aids

The GRADE approach appraises the quality of a body of evidence based on the extent to which one can be confident that an estimate of effect or association reflects the item being assessed. The quality of a body of evidence is based on within-study risk of bias (methodologic quality), the directness of the evidence, heterogeneity of the data, precision of effect estimates, and risk of publication bias (Chapter 12, *Cochrane Handbook for Systematic Reviews of Interventions*) (Higgins 2011)."

Review:

We applied the principles of the GRADE system (Guyatt 2008; Guyatt 2011a) to assess the quality of the body of evidence associated with specific outcomes in our review, and constructed 'Summary of findings' tables (Summary of findings for the main comparison; Summary of findings 2) using GRADEpro GDT for::

1. patient-reported pain at rest on arrival in the postoperative care unit;
2. total number of block-related complications (comparison 2 only);
3. acute confusional state;
4. pruritus;
5. hospital length of stay;
6. walking on postoperative day one or first time to walk;
7. hip flexion at 7 days (comparison 1 only, as a replacement for outcome 2 which was not feasible for comparison 1); and
8. patient satisfaction.

We judged the quality of evidence as high when most information was derived from studies at low risk of bias, and downgraded quality by one level when most information was obtained from studies at high or unclear risk of bias (allocation concealment and blinding of outcome assessors). We downgraded quality by two levels when the proportion of information obtained from studies at high risk of bias was sufficient to affect interpretation of results. In relation to inconsistency, we downgraded the quality of evidence by one level when the I^2 statistic was 50% or higher without satisfactory explanation, and by two levels when the I^2 statistic was 75% or higher without explanation.

We did not downgrade the quality of evidence for indirectness, because all outcomes were based on direct comparisons, were performed on the population of interest and were not surrogate markers (Guyatt 2011b). For imprecision (Guyatt 2011c), we downgraded the quality of evidence by one level when the CI around the effect size was large or overlapped, an absence of effect and failed to exclude an important benefit or harm, or when the number of participants was fewer than the optimal information size. We downgraded evidence quality by two levels when the CI was very wide and included both appreciable benefit and harm.

We downgraded the quality of evidence by one level when correcting for the possibility of publication bias (assessed by Duval and Tweedie's fill and trim analysis) changed the conclusion (Duval 2000; Duval 2000a). Where quality of the body of evidence was assessed as high, further research is very unlikely to change our confidence in the estimate of effect. Where quality was assessed as moderate, further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate. Where quality was low, further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate. Where the quality was very low, any estimate of effect is very uncertain (Guyatt 2008).

Appendices

We deleted the data extraction sheet.

In summary, the method was changed to clarify the comparator and adapt the statistical analyse to simplify it and make similar to all other Cochrane Reviews published by review authors.

INDEX TERMS

Medical Subject Headings (MeSH)

Analgesia [methods]; Arthroplasty, Replacement, Hip [*adverse effects]; Confusion [etiology]; Length of Stay; Nerve Block [adverse effects] [*methods]; Pain Management [*methods]; Pain, Postoperative [*prevention & control]; Pruritus [etiology]; Randomized Controlled Trials as Topic

MeSH check words

Adult; Humans