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[Intervention Review]

Cephalomedullary nails versus extramedullary implants for extracapsular hip fractures in older adults

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ABSTRACT

Background

Hip fractures are a major healthcare problem, presenting a substantial challenge and burden to patients, healthcare systems and society. The increased proportion of older adults in the world population means that the absolute number of hip fractures is rising rapidly across the globe. Most hip fractures are treated surgically. This Cochrane Review evaluates evidence for implants used to treat extracapsular hip fractures.

Objectives

To assess the relative effects of cephalomedullary nails versus extramedullary fixation implants for treating extracapsular hip fractures in older adults.

Search methods

We searched CENTRAL, MEDLINE, Embase, Web of Science, the *Cochrane Database of Systematic Reviews*, Epistemonikos, ProQuest Dissertations & Theses, and the National Technical Information Service in July 2020. We also searched clinical trials databases, conference proceedings, reference lists of retrieved articles, and conducted backward-citation searches.

Selection criteria

We included randomised controlled trials (RCTs) and quasi-RCTs comparing cephalomedullary nails with extramedullary implants for treating fragility extracapsular hip fractures in older adults. We excluded studies in which all or most fractures were caused by a high-energy trauma or specific pathologies other than osteoporosis.

Data collection and analysis

We used standard methodological procedures expected by Cochrane. We collected data for seven critical outcomes: performance of activities of daily living (ADL), delirium, functional status, health-related quality of life, mobility, mortality (reported within four months of surgery as 'early mortality'; and reported from four months onwards, with priority given to data at 12 months, as '12 months since surgery'), and unplanned return to theatre for treating a complication resulting directly or indirectly from the primary procedure (such as deep infection or non-union). We assessed the certainty of the evidence for these outcomes using GRADE.

Main results

We included 76 studies (66 RCTs, 10 quasi-RCTs) with a total of 10,979 participants with 10,988 extracapsular hip fractures. The mean ages of participants in the studies ranged from 54 to 85 years; 72% were women. Seventeen studies included unstable trochanteric fractures; three included stable trochanteric fractures only; one included only subtrochanteric fractures; and other studies included a mix of fracture types. More than half of the studies were conducted before 2010. Owing to limitations in the quality of reporting, we could not easily judge whether care pathways in these older studies were comparable to current standards of care.

We downgraded the certainty of the outcomes because of high or unclear risk of bias; imprecision (when data were available from insufficient numbers of participants or the confidence interval (CI) was wide); and inconsistency (when we noted substantial levels of statistical heterogeneity or differences between findings when outcomes were reported using other measurement tools).

There is probably little or no difference between cephalomedullary nails and extramedullary implants in terms of mortality within four months of surgery (risk ratio (RR) 0.96, 95% CI 0.79 to 1.18; 30 studies, 4603 participants) and at 12 months (RR 0.99, 95% CI 0.90 to 1.08; 47 studies, 7618 participants); this evidence was assessed to be of moderate certainty. We found low-certainty evidence for differences in unplanned return to theatre but this was imprecise and included clinically relevant benefits and harms (RR 1.15, 95% CI 0.89 to 1.50; 50 studies, 8398 participants). The effect estimate for functional status at four months also included clinically relevant benefits and harms; this evidence was derived from only two small studies and was imprecise (standardised mean difference (SMD) 0.02, 95% CI -0.27 to 0.30; 188 participants; low-certainty evidence). Similarly, the estimate for delirium was imprecise (RR 1.22, 95% CI 0.67 to 2.22; 5 studies, 1310 participants; low-certainty evidence). Mobility at four months was reported using different measures (such as the number of people with independent mobility or scores on a mobility scale); findings were not consistent between these measures and we could not be certain of the evidence for this outcome. We were also uncertain of the findings for performance in ADL at four months; we did not pool the data from four studies because of substantial heterogeneity. We found no data for health-related quality of life at four months.

Using a cephalomedullary nail in preference to an extramedullary device saves one superficial infection per 303 patients (RR 0.71, 95% CI 0.53 to 0.96; 35 studies, 5087 participants; moderate-certainty evidence) and leads to fewer non-unions (RR 0.55, 95% CI 0.32 to 0.96; 40 studies, 4959 participants; moderate-certainty evidence). However, the risk of intraoperative implant-related fractures was greater with cephalomedullary nails (RR 2.94, 95% CI 1.65 to 5.24; 35 studies, 4872 participants; moderate-certainty evidence), as was the risk of later fractures (RR 3.62, 95% CI 2.07 to 6.33; 46 studies, 7021 participants; moderate-certainty evidence). Cephalomedullary nails caused one additional implant-related fracture per 67 participants. We noted no evidence of a difference in other adverse events related or unrelated to the implant, fracture or both.

Subgroup analyses provided no evidence of differences between the length of cephalomedullary nail used, the stability of the fracture, or between newer and older designs of cephalomedullary nail.

Authors' conclusions

Extramedullary devices, most commonly the sliding hip screw, yield very similar functional outcomes to cephalomedullary devices in the management of extracapsular fragility hip fractures. There is a reduced risk of infection and non-union with cephalomedullary nails, however there is an increased risk of implant-related fracture that is not attenuated with newer designs. Few studies considered patient-relevant outcomes such as performance of activities of daily living, health-related quality of life, mobility, or delirium. This emphasises the need to include the core outcome set for hip fracture in future RCTs.

PLAIN LANGUAGE SUMMARY

Metal implants used to fix broken bones near the hip joint in older adults

Key messages

- Extramedullary implants produce very similar outcomes overall to cephalomedullary nails in the treatment of this type of hip fracture.

- There is a reduced risk of infection and non-union (in which the bone fails to heal) with cephalomedullary nails, but an increased risk of implant-related fracture.

Hip fractures in older people

A hip fracture is a break at the top of the thigh bone. In this review, we included people with a break near the hip joint. These types of broken hip are common in older adults whose bones may be fragile because of a condition called osteoporosis. They often happen after a fall from a standing or sitting position.

What are the treatments?

A common way of mending this type of break is to fix the broken parts of bone with metal implants.

- During an operation, the surgeon may insert a metal rod (nail) through the top of the leg bone down towards the knee. This nail (called a cephalomedullary nail) is held in place with screws.

- Alternatively, the surgeon may use a metal plate which sits on the outer edge of the broken bone (called an extramedullary implant) which is attached to the bone with screws.

What did we do?

We searched for studies that compared these two types of treatment. We wanted to find out the benefits and harms of these different treatments. We combined the findings from studies to see if we could find out if one treatment was better than another.

What did we find?

We found 76 studies, involving a total of 10,979 adults with 10,988 hip fractures. The average age of study participants ranged from 54 to 85 years and 72% were women; this is usual for people who have this type of fracture.

We found that there is probably little difference between treatment with a cephalomedullary nail or an extramedullary implant in the number of people who die within four months of surgery or at 12 months. There may be little or no difference in the number of people who experience confusion (also called delirium) after their surgery, and little or no difference in hip function (ability to use the hip) at four months after surgery. There may also be little or no difference in the number of people who need an additional operation on their broken hip. We are unsure whether there is a difference in how well a person can perform their daily activities, or in their health-related quality of life at four months. We are also unsure whether cephalomedullary nails improve a person's ability to walk independently (with no more than one walking stick) at four months.

We also looked at possible side effects (or harms) from the fracture itself or from using one or other of the implants. For most types of common side effects in hip fracture surgery, there was no evidence of a difference between these two types of implants. We found that fewer people had an infection at the site of surgery, or a broken bone that failed to heal (called a non-union), when a cephalomedullary nail was used. However, more people had a fracture during or after surgery when a cephalomedullary nail was used.

Are we confident in what we found?

- We are moderately confident in the findings about how many people die after surgery. A large number of studies reported this, and the findings were often similar.

- We were less confident about the evidence for delirium, hip function, and additional operations. These findings included the possibility of a benefit with one of the treatments (for example, fewer operations) as well as the possibility of harm (for example, more operations).

- We were very unsure about the findings for how well people could perform their daily activities. This was because we could not explain the wide differences between findings in each study.

- We were unsure about the findings for health-related quality of life because we could not account for the number of participants lost during study follow-up.

- We were also unsure about the findings for a person's ability to walk independently four months after surgery. This was because studies measured walking ability in different ways, and they sometimes had different findings.

All the evidence that we found included at least some studies that had not clearly reported methods used to randomise participants (i.e. to allocate them by chance) to one of the two types of implants. These studies, with less rigorous study designs, might affect our findings.

How up-to-date is this review?

The evidence is up-to-date to July 2020.

Summary of findings 1. Cephalomedullary nails compared to extramedullary implants for extracapsular hip fractures in adults

Cephalomedullary nails compared to extramedullary implants for extracapsular hip fractures in adults

Population: older adults with stable or unstable extracapsular hip fractures
Setting: hospitals; included studies were conducted in: Australia, Austria, Brazil, Canada, China, Denmark, Finland, France, Greece, Hong Kong, India, Iran, Israel, Italy, Japan, Mexico, New Zealand, Norway, Pakistan, South Korea, Spain, Sweden, Switzerland, The Netherlands, Turkey, USA, UK
Intervention: cephalomedullary nails (Gamma nail, Gamma 3 nail, PFN, ultra-short PFN, expandable PFN, PFNA, Targon PFN, TRIGEN INTERTAN nail, Holland nail, Küntscher-Y nail)
Comparison: extramedullary implants (SHS, DHS, ABMI hip screw, compression hip screw, LISS, Medoff sliding plate, blade plates, percutaneous compression plate, dynamic Condylar screw, locking compression plate)

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with extramedullary implants	Risk with cephalomedullar nails				
Activities of daily living (ADL), early (≤ 4 months): using LEM (range from 0 to 100), FIM (range from 0 to 100), JOA (range from 0 to 20); higher scores indicate better performance in ADL Follow-up: time points in the included studies were at 4 weeks and 3 months	-	-	-	509 (4 studies)	**Very low** [a]	We did not pool data because of high statistical heterogeneity.
Delirium (at end of follow-up) Follow-up: time points in the included studies were 4 months and 12 months	Study population		**RR 1.22** (0.67 to 2.22)	1310 (5 studies)	**Low** [c]	
	30 per 1,000[b]	**37 per 1000** (20 to 67)				
Functional status, early (≤ 4 months): using Zűckerman functional recovery score (0 to 44), and 100-point functional recovery scale; in both scales, higher scores indicate better function Follow-up: time points in the included studies were at 3 months and 4 months			**SMD 0.02 higher** (-0.27 lower to 0.3 higher)	188 (2 studies)	**Low** [c]	This effect did not indicate a clinically important difference, based on a 'rule of thumb' of: 0.2 for a small difference, 0.5 for a medium difference, and 0.8 for a large difference.

						Using the Zűckerman functional recovery score, this equates to a MD of 0.22 (this is unlikely to represent a clinically important difference on this 44-point scale)
Health-related quality of life, early (≤ 4 months)	-	-	-			Inestimable
Mobility (≤ 4 months): assessed as number of participants with independent mobility Follow-up: time points in the included studies were at 3 months and 4 months	Study population 594 per 1,000[b]	 **665 per 1000** (600 to 730)	**RR 1.12** (1.01 to 1.23)	719 (7 studies)	**Very low** [d]	
Mortality, early (≤ 4 months) Follow-up: time points in the included studies were during early postoperative period, within hospital, and at 1 month, 3 months, and 4 months	Study population 83 per 1,000[b]	 **80 per 1000** (66 to 98)	**RR 0.96** (0.79 to 1.18)	4603 (30 studies)	**Moderate**[e]	
Mortality at 12 months Follow-up: time points in the included studies were at 5 months, 6 months, 12 months, and 24 months	Study population 204 per 1000[b]	 **202 per 1000** (184 to 220)	**RR 0.99** (0.90 to 1.08)	7618 (47 studies)	**Moderate**[e]	
Unplanned return to theatre (at end of follow-up) Follow-up: time points in the included studies were 3 months, 4 months, 5 months, 6 months, 12 months, and 24 months	Study population 43 per 1,000[b]	 **49 per 1000** (38 to 64)	**RR 1.15** (0.89 to 1.50)	8398 (50 studies)	**Low**[f]	

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

AMBI: manufacturer name for implant; **CI:** confidence interval; **DHS:** dynamic hip screw; **FIM:** functional independence measure; **JOA:** Japanese Orthopaedic Association;**LEM:** lower extremity measure; **LISS:** less invasive stabilisation system; **MD:** mean difference; **PFN:** proximal femoral nail; **PFNA:** proximal femoral nail antirotation; **RR:** risk ratio; **SHS:** sliding hip screw; **SMD:** standardised mean difference

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: we are moderately confident in the effect estimate. The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low certainty: our confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of the effect
Very low certainty: we have very little confidence in the effect estimate. The true effect is likely to be substantially different from the estimate of effect

[a]Downgraded by three levels: one level for serious risks of bias and two levels for inconsistency owing to high levels of unexplained statistical heterogeneity
[b]Derived from the pooled estimate of the cephalomedullary nails group
[c]Downgraded by two levels: one level for serious risks of bias, and one level owing to imprecision denoted by the wide CI in this estimate.
[d]Downgraded by two levels for serious risks of bias, and one level for inconsistency because this effect was not always apparent in other measures of early mobility (such as when measured using mobility scores)
[e]Downgraded by one level for serious risks of bias
[f]Downgraded by two levels: one level for serious risks of bias because all studies in this analysis were at high risk of detection bias, and one level for imprecision denoted by the wide CI in this estimate

BACKGROUND

Description of the condition

Hip fracture is the general term for fracture of the proximal (upper) femur. These fractures can be subdivided into intracapsular fractures (those occurring within or proximal to the attachment of the hip joint capsule to the femur) and extracapsular (those occurring outside or distal to the hip joint capsule). Extracapsular hip fractures are defined as those fractures of the proximal femur within the area of bone from the attachment of the hip joint capsule to a level of five centimetres below the distal (lower) border of the lesser trochanter. Other terms used to describe these fractures include trochanteric, subtrochanteric, pertrochanteric and intertrochanteric fractures. These terms reflect the proximity of these fractures to the greater and lesser trochanters, which are two bony protuberances (bulges) at the upper end of the femur outside the joint capsule (Parker 2002).

Hip fractures occur predominantly in older people (aged over 65 years), especially women. In the UK, the mean age of a person with hip fracture is 83 years, and approximately two-thirds occur in women (NHFD 2019). The relative proportion of extracapsular fractures also varies: 39% of hip fractures were extracapsular fractures in Bjorgul 2007, and 48% in Karagas 1996. A summary of the case-mix for the 65,000 hip fractures occurring in 2018/19 in 175 hospitals in England, Wales and Northern Ireland was presented by an annual report of the National Hip Fracture Database (NHFD 2019). This showed that around three-quarters of hip fractures (72.3%) occurred in women and over 91.1% of cases were aged over 70 years; around 40% of fractures were extracapsular.

Numerous subdivisions and classification methods exist for these fractures. The most practical classification, and that used for this review, is the basic division into stable trochanteric fractures (AO classification type A1) (Muller 1991) and unstable trochanteric fractures (AO classification type A2 and A3), with a separate category for subtrochanteric fractures. Stable trochanteric fractures are two-part fractures in which the fracture line runs obliquely (at an angle) between the lesser and greater trochanter of the femur. Unstable trochanteric fractures again have an oblique fracture line running between the trochanters but in addition, there is comminution (multi-fragmentation) of the fracture site. The comminution fragments may be the lesser trochanter, greater trochanter or both of these parts of the femur. Those fractures at the level of the lesser trochanter (AO A3, transtrochanteric) have a slightly more distally (lower) based fracture line which either runs transversely (across the bone) at the level of the lesser trochanter or in an oblique direction that is opposite (reverse) to that of stable and unstable trochanteric fractures. Transtrochanteric fractures may be two-part or comminuted. This fracture pattern allows the femur to be displaced medially due to the pull of the abductor muscles. Subtrochanteric fractures are those fractures in which the fracture crossing the femur is predominately found within the five centimetres of bone immediately below the lesser trochanter. These fractures may be two-part or comminuted and, in some instances, the fracture may extend proximally into the trochanteric region or distally into the shaft of the femur.

Description of the intervention

Operative treatment of extracapsular hip fractures was introduced in the 1950s using a variety of different implants. Implants may be either extramedullary or cephalomedullary in design. Worldwide, the most commonly used extramedullary implant is the sliding hip screw (SHS), which is synonymous with the term compression hip screw and equivalent models such as the Dynamic, Richards or AMBI hip screws. The SHS consists of a lag screw passed up the femoral neck to the femoral head. This lag screw is then attached to a plate on the side of the femur. These are considered 'dynamic' implants as they have the capacity for sliding at the plate/screw junction to allow for collapse at the fracture site, resulting in compression between the main fracture fragments. The Medoff plate (Medoff 1991) is a modification of the SHS. The difference is that the plate has an inner and outer sleeve, which can slide between each other. This creates additional capacity for sliding to occur at the level of the lesser trochanter as well as at the lag screw. Sliding at the lag screw can be prevented with a locking screw to create a 'one way' sliding Medoff instead of a 'two way' sliding Medoff. At a later date, the locking device on the lag screw can be removed to 'dynamise' the fracture. Another dynamic extramedullary device is the percutaneous compression plate (PCCP) (Orthofix), a minimally invasive device that is placed via two small incisions. It uses two smaller screws in the femoral head (as opposed to one large screw) to minimise damage to the lateral cortex and provide rotational stability.

Extramedullary devices may also be static devices; these do not allow collapse at the fracture site. These include pre-contoured locking plates which allow placement of multiple screws in the femoral head that are locked into the plate, thereby preventing movement at the fracture site (e.g. the proximal femoral locking plate (PFLP)) and fixed nail plates such as the Jewett and the McLaughlin nail plates. Pre-contoured locking plates designed for the distal (lower) femur may also be used as static fixed-angle devices for extracapsular hip fractures by using them in a reverse position on the opposite proximal (upper) femur (e.g. reverse distal femoral less invasive stabilisation system (LISS) plates (rDF LISS) (DePuy Synthes) or the reverse distal femoral locking plate (rDFLP)). The 90- or 95-degree blade plate is also a static extramedullary device. Though theoretically, the dynamic condylar screw plate has the capacity for sliding at the screw plate junction, it is more likely to act as a static device when used at the hip, with no slide occurring. Table 1 provides further details on the extramedullary devices assessed by the included trials in this review.

Cephalomedullary nails used for internal fixation of extracapsular fractures can either be inserted from distal to proximal (condylocephalic nails; Parker 1998) or from proximal to distal (cephalocondylic nails). Cephalocondylic nails are inserted through the greater trochanter of the femur and secured by a screw which is passed through the proximal part of the nail (or vice versa), up the femoral neck into the femoral head. Theoretical biomechanical advantages of these cephalomedullary nails over screw-and-plate fixation are attributed to a reduced distance between the hip joint and the implant, which diminishes the bending moment across the implant/fracture construct.

Another potential biomechanical advantage is that fixation with cephalomedullary nails results in less femoral medialisation. The reason nails reduce femoral medialisation is that the proximal part of the nail acts as a lateral buttress that sits inside the proximal

femur; this reduces the potential space for fractured osteoporotic bone to collapse into (Ong 2019). More femoral medialisation has been shown to result in inferior mobility because the hip abductor muscles are detensioned and so cannot work as well (Bretherton 2016).

Examples of cephalomedullary nails are the Gamma nail (Stryker-Howmedica), the cephalomedullary hip screw (IMHS) (Smith & Nephew), the proximal femoral nail (PFN) (Synthes), the proximal femoral nail antirotation (PFNA) (Synthes), the Targon PF (proximal femoral) nail (B. Braun), the Holland nail and the Küntscher-Y nail (Cuthbert 1976). Condylocephalic nails are inserted into the distal femur and passed up the cephalomedullary cavity across the fracture site and up into the femoral head; these nails are not included in this review. The best-known type of this nail is the Ender nail. Table 2 presents further information on the cephalomedullary nails assessed by the included trials in this review. A review comparing different cephalomedullary nails for these fractures is available (Queally 2014).

Why it is important to do this review

There is controversy over the choice of implant, especially the use of cephalomedullary nails versus sliding hip screws, for extracapsular hip fractures. Indeed, studies reporting a rapid increase in the use of cephalomedullary nails in the USA have pointed out, citing an earlier version of this review, that this phenomenon is not supported by the available evidence (Anglen 2008; Forte 2008; Forte 2010). The availability of new evidence — often on new implants that are aimed at avoiding the complications of cephalomedullary fixation (specifically, operative and later femoral fracture) — indicate a need to update this Cochrane Review (Parker 2010), which continues to compare different types of cephalomedullary nails with extramedullary implants.

The need for this review update was endorsed by a prioritisation process conducted as part of a National Institute for Health Research (NIHR)-funded Cochrane Programme Grant on the management of hip fracture. This additionally provided the rationale for modifications to the review's protocol, together with the collection of additional context data and provision of additional results that might better inform current practice.

OBJECTIVES

To assess the relative effects of cephalomedullary nails versus extramedullary fixation implants for treating extracapsular proximal femoral (hip) fractures in older adults.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) and quasi-RCTs comparing cephalocondylic intramedullary (cephalomedullary) nails with extramedullary implants in extracapsular hip fracture. Quasi-RCTs are defined as trials in which the methods of allocating participants to an intervention are not random, but are intended to produce groups with similar future outcomes (Cochrane 2018). We included published papers and conference abstracts if they provided sufficient data relating to the methods and outcomes of interest.

Types of participants

We included older adults (at least 60 years of age) undergoing surgery in a hospital setting for an extracapsular proximal femoral fracture. We included trochanteric (stable or unstable) or subtrochanteric fractures which we expected to be caused by low-energy trauma.

We expected trial populations to have a mean age of between 80 and 85 years, to include 70% women, 30% with chronic cognitive impairment, and 50% with an American Society of Anesthesiologists (ASA) score greater than two to indicate that a patient has no more than mild systemic disease without significant functional limitation (NHFD 2019; NICE 2011). This would be representative of the general hip-fracture population.

We excluded studies that focused exclusively on the treatment of participants younger than 60 years of age, of participants with fractures caused by specific pathologies other than osteoporosis, and of participants with high-energy fractures. However, we took a pragmatic approach to study inclusion criteria and included studies with mixed populations (fragility and other mechanisms, ages, or pathologies). We expected that the proportion of participants with standard fragility fractures was most likely to outnumber those with high-energy or local pathological fractures; therefore, the results would be generalisable to the fragility-fracture population. If the data were reported separately for fragility fractures, we planned to use these subgroup data for our main analyses. We considered it unlikely that participants under 60 years of age would have experienced a fragility hip fracture caused by low-energy trauma.

Types of interventions

We included surgical fixation of the fracture with a cephalomedullary nail or with an extramedullary implant. In our categorisation of implants we noted the key design characteristics of the type of implant, as well as assessing their current use worldwide. For cephalomedullary nails, we considered short and long nails, and dynamic versus static implants. For extramedullary implants, we considered dynamic versus static devices. For descriptions of the cephalomedullary nails and extramedullary implants evaluated in the included trials, see Table 1 and Table 2.

Types of outcome measures

Depending on the length of follow-up reported, we categorised the end points for outcomes into early (up to and including four months) or 12 months (prioritising 12-month data, but in their absence including any data after four months). We selected four months as the definition of early because most of early recovery has been achieved at this time point (Griffin 2015). This is also in accordance with the core outcome set for hip fracture, which prioritises early outcome over late recovery (Haywood 2014). Although priority was given to early outcomes in the presentation of our data, we also included outcome data at late time points, and we therefore included all outcomes without a time limit.

Critical outcomes

We extracted information on the following seven 'critical' outcomes.

- Activities of daily living (e.g. Barthel Index (BI), Functional Independence Measure (FIM)).

- Delirium, using recognised assessment scores such as Mini-mental state examination (MMSE) or the 4 'A's Tests (4AT) and the Abbreviated Mental Test Score (AMTS).
- Functional status (region-specific) (e.g. hip rating questionnaire, Harris Hip Score, Oxford Hip Score).
- Health-related quality of life (e.g. Short Form Health Survey (SF-36), EuroQol- 5 Dimension (EQ-5D)).
- Mobility (e.g. indoor/outdoor walking status, Cumulated Ambulation Score, Elderly Mobility Scale score, Timed Up and Go test, Short Physical Performance Battery, Parker mobility score (Parker 1993), self-reported walking scores (e.g. Mobility Assessment Tool — short form)).
- Mortality.
- Unplanned return to theatre: secondary procedure required for a complication resulting directly or indirectly from the index operation/primary procedure measured at the end of study follow-up.

Other important clinical outcomes

We also reported the following 'important' outcomes. Where relevant, we categorised these into early (up to and including four months) and late (after four months).

- Pain (verbal rating or visual analogue scale (VAS)).
- Length of in-hospital stay.
- Discharge destination. We used study authors' definitions, which were variably defined in the included studies.
- Adverse events.

We also grouped adverse events by relatedness to the implant or fracture, or both. We reported each adverse event type separately for maximum clarity. We anticipated that events may have included the following.

Related adverse events

- Damage to a nerve, tendon or blood vessel
- Intraoperative periprosthetic fracture
- Postoperative periprosthetic fracture
- Loosening of prosthesis
- Screw cut-out
- Implant failure
- Wound infection (we used study authors' definitions, which were often described as deep infection or superficial infection)

Unrelated adverse events

- Acute kidney injury
- Blood transfusion
- Cerebrovascular accident
- Chest infection/pneumonia
- Decreased cognitive ability
- Myocardial infarction/acute coronary syndrome
- Sepsis
- Urinary tract infection
- Venous thromboembolic phenomena (deep vein thrombosis and pulmonary embolism)

Search methods for identification of studies

As well as developing a strategy for this review, we developed general search strategies for the large bibliographic databases to find records to feed into a number of Cochrane Reviews and review updates on hip fracture surgery (Lewis 2021; Lewis 2022a; Lewis 2022b; Lewis 2022c). We searched the main databases up to July 2020.

Electronic searches

We identified RCTs and quasi-RCTs through literature searching with systematic and sensitive search strategies, as outlined in Chapter 4 of the *Cochrane Handbook of Systematic Reviews of Interventions* (Lefebvre 2019). We applied no restrictions on language, date, or publication status. We searched the following databases for relevant trials.

- Cochrane Central Register of Controlled Trials (CENTRAL; CRS Web; 8 July 2020).
- MEDLINE (Ovid; 1946 to 6 July 2020).
- Embase (Ovid; 1980 to 7 July 2020).
- Web of Science (SCI EXPANDED; 1900 to 8 July 2020).
- *Cochrane Database of Systematic Reviews* (CDSR; the Cochrane Library; 7 July 2020).
- Database of Abstracts of Reviews of Effects (DARE; www.crd.york.ac.uk/CRDWeb/; 17 December 2018).
- Health Technology Assessment (HTA) database (www.crd.york.ac.uk/CRDWeb/; 17 December 2018).
- Epistemonikos (www.epistemonikos.org/; 9 July 2020).
- Proquest Dissertations and Theses (ProQuest; 1743 to 8 July 2020).
- National Technical Information Service (NTIS, for technical reports; www.ntis.gov/; 10 July 2020).

We developed a subject-specific search strategy in MEDLINE and other listed databases; we adapted strategies with consideration of differences between database interfaces as well as different indexing languages. In MEDLINE, we used the sensitivity-maximising version of the Cochrane Highly Sensitive Search Strategy for identifying randomised trials (Lefebvre 2019). In Embase, we used the Cochrane Embase filter (www.cochranelibrary.com/central/central-creation) to focus on RCTs. The initial search was run in November 2018 and December 2018, and a top-up search was run in July 2020 in all databases except for DARE and HTA, in which no new records have been added since the initial search. At the time of the search, CENTRAL was fully up-to-date with all records from the Cochrane Bone, Joint, and Muscle Trauma (BJMT) Group's Specialised Register, and so it was not necessary to search this separately. We developed the search strategy in consultation with Information Specialists (see Acknowledgements) and the Information Specialist for Cochrane BJMT. Search strategies can be found in Appendix 1.

We scanned ClinicalTrials.gov (www.clinicaltrials.gov/) for ongoing and unpublished trials on 10 July 2020. Details of the search strategies used for previous versions of the review are given in Parker 2010.

Searching other resources

We handsearched the following conference abstracts from 2016 to November 2018.

- Fragility Fractures Network Congress.
- British Orthopaedic Association Congress.
- Orthopaedic World Congress (SICOT).
- Orthopaedic Trauma Association Annual Meeting.
- *The Bone & Joint Journal Orthopaedic Proceedings*.
- American Academy of Orthopaedic Surgeons Annual Meeting.

In addition, one review author (MJP) kept updated records of all related publications which we used during interim work on this update.

Data collection and analysis

In order to reduce bias, we ensured that any review author who is also a study author, co-applicant on the Cochrane Programme Grant on the management of hip fracture, or has had an advisory role on any potentially relevant study, remained independent of study selection decisions, risk of bias assessment and data extraction for their study.

Selection of studies

Two review authors screened titles and abstracts of all the retrieved bibliographic records in a web-based systematic reviewing platform, Rayyan (Ouzzani 2016), and in the top-up search using Covidence. Full texts of all potentially eligible records passing the title and abstract screening level were retrieved and examined independently by two review authors, using the eligibility criteria outlined in Criteria for considering studies for this review. Full-text screening was conducted using Covidence. Disagreements were resolved by discussion or adjudication by a third review author. Duplicates were excluded and multiple reports of the same study collated so that each study, rather than each report, was the unit of interest in the review. We prepared a PRISMA flow diagram to outline the study selection process, numbers of records at each stage of selection, and reasons for exclusions of full-text articles (Moher 2009). We reported in the review details of key excluded studies, rather than all studies that were excluded from consideration of full-text articles.

Since publication of the previous review (Parker 2010), some additional review authors conducted interim searches for the review. Results were incorporated in a non-published review file (see Acknowledgements).

Data extraction and management

All review authors conferred on the essential data for extraction, and a form was structured to align with default headings in the Characteristics of included studies (see Appendix 2). Two review authors piloted the form on five studies and compared results. We then made changes to the template following additional discussion with the author team. For the remaining data extraction, one review author independently extracted data and a second review author checked all the data for accuracy. We extracted the following data.

- Study methodology: publication type; sponsorship/funding/notable conflicts of interest of trial authors; study design; number of centres and locations; size and type of setting; study inclusion and exclusion criteria; randomisation method; number of randomised participants, losses (and reasons for losses), and number analysed for each outcome. (Collecting information relating to the participant flow helped with the assessment of risk of attrition bias.)
- Population: baseline characteristics of the participants by group and overall (age, gender, smoking history, medication, body mass index (BMI), comorbidities, functional status such as previous mobility, place of residence before fracture, cognitive status, American Society of Anesthesiologists (ASA) status, fracture type and stability).
- Interventions: details of each intervention (number and type, manufacturer details); general surgical details (number of clinicians and their skills and experience, perioperative care such as use of prophylactic antibiotics or antithromboembolics, mobilisation or weight-bearing protocols).
- Outcomes: all outcomes measured or reported by study authors; outcomes relevant to the review (including measurement tools and time points of measure); extraction of outcome data into data and analysis tables or additional tables in Review Manager 2020.

As above, a previous review author team conducted interim data extraction, and we supplemented this with additional data extraction using these criteria (see Acknowledgements).

Assessment of risk of bias in included studies

We assessed risk of bias in the included studies using the Cochrane risk of bias tool (Higgins 2011). We assessed the following domains.

- Random sequence generation (selection bias).
- Allocation concealment (selection bias).
- Blinding of participants and personnel (performance bias).
- Blinding of outcome assessors (detection bias).
- Incomplete outcome data (attrition bias).
- Selective reporting (reporting bias).
- Other risks of bias.

In addition, we also considered performance bias related to the experience of the clinicians (whether clinicians were equally experienced with the implants used in the study). We considered risk of detection bias separately for: subjective outcomes measured by clinicians, objective outcomes measured by clinicians, and participant-reported outcomes (e.g. pain and health-related quality of life). For each domain, two review authors judged whether study authors made sufficient attempts to minimise bias in their design. For each domain, we made judgements using three measures — high, low, or unclear risk of bias — and we recorded these judgements in risk of bias tables.

Measures of treatment effect

We calculated risk ratios (RRs) for dichotomous data outcomes with 95% confidence intervals (CIs); it was not appropriate to use Peto odds ratio (OR) to calculate effects because no outcomes had very low numbers of observed events. We expressed treatment effects for continuous data outcomes as mean differences (MDs) with 95% CIs; if the outcomes were measured using different scales, we planned to use standardised mean differences (SMDs) with 95% CIs.

In the event that studies reported dichotomous data using more than one category, we selected the following cut-off points in the distribution of categories.

- For functional status: we reported data for those with a score of excellent or good (using Harris Hip Score (HHS)) versus those with a score of moderate or poor.
- For mobility: we reported data for those who were able to walk independently out of doors with no more than the use of one stick (NICE 2011), versus those who were more dependent.
- For pain: we reported data for participants who reported no pain versus those who reported any category of pain.
- For discharge destination: we reported data for participants who were discharged home versus those who were discharged to a care environment.

Unit of analysis issues

In preparation of the review, we encountered potential unit of analysis issues. We found that some studies reported the number of hip fractures (or cases) as well as the number of participants, with a very small number of participants having two fractured hips. Often, differentiating the denominators within a report was challenging. In such studies, depending on the outcome, the unit of analysis was either the participant (for example, for outcomes such as mortality, discharge destination, or some adverse events) or the hip (for example, for outcomes such as unplanned return to theatre). We noted this differentiation where applicable and used the unit of analysis (participants or case) that was appropriate for the outcome within these studies. One study included more than two interventions (Papasimos 2005); in the analysis, we combined data from the two cephalomedullary groups (trochanteric Gamma nails and proximal femoral nails) and compared these to the extramedullary intervention arm (AMBI hip screw).

Dealing with missing data

For each included study, we recorded the number of participant losses for each outcome. Unless reported otherwise, we assumed complete case data for mortality, unplanned return to theatre and adverse events. For outcomes that required participant assessment at end of follow-up (such as health-related quality of life), we prioritised intention-to-treat (ITT) data where these data were available. If ITT data were unavailable for these outcomes, and if study authors did not clearly report denominator figures for each group for the outcome, we reduced the denominator figure in each group to account for reported mortality. We did not impute missing data. We used the risk of bias tool to judge attrition bias. We judged studies to be at high risk of attrition bias if we noted large amounts of unexplained missing data, losses that could not be easily justified in the study population, or losses that were not sufficiently balanced between intervention groups. If we included a study with high attrition bias, we explored the effect during sensitivity analysis. We completed sensitivity analysis only for critical review outcomes and only considered attrition for outcomes that may be affected by these losses.

We attempted contact with study authors of more recently published trials when we noted that data for critical outcomes appeared to have been measured but not reported. For older studies, we used data collected by previous author teams; this included data from direct communication with study authors. Where standard deviations were not reported, we attempted to determine these from other reported data (such as standard errors, CIs, or exact P values). We noted in the Characteristics of included studies tables when we could not use outcome data because they were insufficiently reported or because numbers of losses in each group were not clearly specified.

Assessment of heterogeneity

We used the I^2 statistic, automatically calculated in Review Manager 2020, to quantify the possible degree of heterogeneity of treatment effects between trials. We assumed there to be moderate heterogeneity when the I^2 was between 30% and 60%; substantial heterogeneity when it was between 50% and 90%; and considerable heterogeneity when it was between 75% and 100%. We noted the importance of I^2 depending on: 1) magnitude and direction of effects; and 2) strength of evidence for heterogeneity. We investigated statistical heterogeneity using subgroup analysis in the event of at least 10 studies (Deeks 2021).

We assessed clinical and methodological diversity in terms of participants, interventions, outcomes, effect modifiers, and study characteristics for the included studies to determine whether a meta-analysis was appropriate; we used the information collected during data extraction (Data extraction and management).

Assessment of reporting biases

We planned to investigate the potential for publication bias and explore possible small-study biases using funnel plots. However, there were insufficient studies (fewer than 10) for most outcomes. For outcomes with 10 or more studies, we constructed a funnel plot and interpreted the plot using a visual inspection and the Harbord modified test in Stata; for the critical review outcomes we reported P values for the Harbord modified test or Egger's test. We incorporated this judgement into the assessment of publication bias within the GRADE assessment.

To assess outcome reporting bias, we screened clinical trials registers for protocols and registration documents of included studies that were prospectively published, and we sourced all clinical trials register documents that were reported in the study reports of included studies. We used evidence of prospective registration to judge whether studies were at risk of selective reporting bias.

Data synthesis

We conducted meta-analyses only when meaningful, that is, when the treatments, participants, and the underlying clinical question were similar enough for pooling to make sense. We pooled results of comparable groups of trials using random-effects models. This model was chosen after careful consideration of the extent to which any underlying effect could truly be thought to be fixed, given the complexity of the interventions included in this review. We presented 95% CIs throughout.

We found that some studies reported outcome data at more than one time point, and where possible, we reported data within two time point windows. Early data included data up to four months (with priority given to data closest to four months for studies that reported multiple time points within this window); 12-month data included a window from later than four months and up to 24 months, but with priority being given to data at 12 months.

For studies that reported outcome data using more than one measurement tool, we selected the tool that was used most commonly by other studies in the comparison group, or which reported data for the most number of participants. For mobility, we prioritised data from mobility scores, followed by dichotomous data for independent mobility.

We considered the appropriateness or otherwise of pooling data where there was considerable heterogeneity (I^2 statistic value of greater than 75%) that could not be explained by the diversity of methodological or clinical features among trials. We presented data from these studies in the analyses and clearly reported these observations in the text for the critical outcomes in the review.

Subgroup analysis and investigation of heterogeneity

Although we aimed to explore possible sources of heterogeneity between studies (key effect modifiers such as age, gender, cognitive impairment, and functional status), we found insufficient studies reporting these data in a manner to allow for meaningful analysis. In addition, we noted that few studies sufficiently reported some of these possible effect modifiers.

We completed subgroup analysis on length of cephalomedullary nails (long and short nails). We found that some studies included both long and short nails; in other studies, the length of nail was not reported, and we included these in a subgroup for mixed or unknown nail lengths.

We also conducted subgroup analysis on fracture type (stable and unstable trochanteric fractures). We based the subclassification for fracture instability on either the trial authors' classification of unstable or stable fractures. However, if the study authors reported these data according to the AO classification system, we used this in preference to other classification systems: we considered that A1 were stable fractures and A2 (A2.1, 2.2 and 2.3) and A3 were unstable trochanteric fractures. We found several studies that included a mixed population of stable and unstable fractures or did not report the fracture subtypes, and we therefore included a third subgroup for 'mixed/unknown' fracture type. We did not include studies exclusively including subtrochanteric fractures in this subgroup analysis.

We conducted a post hoc subgroup analysis for intraoperative and postoperative periprosthetic fractures. We noted that other reviews indicated that there may be fewer periprosthetic fractures in more recent studies because of improved implant designs (Bhandari 2009; Noris 2012). We therefore subgrouped these outcome data according to studies published before 2010 and from 2010 onwards.

We investigated whether the results of subgroups were significantly different by inspecting the overlap of CIs and performing the test for subgroup differences available in Review Manager 5 (Review Manager 2020).

Sensitivity analysis

We used sensitivity analysis to explore the effects of risks of bias on the review for critical outcomes. We performed analyses in which we excluded studies that met the following criteria.

- Studies at high or unclear risk of selection bias for random sequence generation (this included studies that were described as quasi-randomised, or that did not adequately describe methods used to randomise participants to intervention groups).
- Studies at high risk of attrition bias (because studies reported a large number of losses that were unexplained or not justified for this population, or that were unbalanced between groups, and that we expected could influence outcome data).
- Studies at high risk of performance bias (because the surgeons did not have comparable experience with both types of study implants).
- Studies that used an extramedullary implant with static design.

Summary of findings and assessment of the certainty of the evidence

Two review authors used the GRADE system to assess the certainty of the body of evidence associated with the following seven critical outcomes in the review (Guyatt 2008).

- Activities of daily living.
- Delirium.
- Functional status.
- Health-related quality of life.
- Mobility.
- Early mortality (measured within four months of surgery, and at 12 months).
- Unplanned return to theatre.

For outcomes that were reported using more than one measurement tool, and that could not be combined in analysis, we assessed the certainty of the evidence for the outcome that used a measurement tool with the most participants. We only assessed the certainty of evidence when the evidence was supported by data with effect estimates. The GRADE approach assesses the certainty of a body of evidence based on the extent to which we can be confident that an estimate of effect or association reflects the item being assessed. Evaluation of the certainty of a body of evidence considers within-study risk of bias, directness of the evidence (indirectness), heterogeneity of the data (inconsistency), precision of the effect estimates (imprecision), and risk of publication bias. The certainty of the evidence could be high, moderate, low or very low, being downgraded by one or two levels depending on the presence and extent of concerns in each of the five GRADE domains. We used footnotes to describe reasons for downgrading the certainty of the evidence for each outcome, and we used these judgements when drawing conclusions in the review.

We constructed a summary of findings table for the comparison of cephalomedullary nails versus extramedullary implants, using GRADE profiler software, to present the certainty of the evidence for these seven critical outcomes (GRADEpro GDT). We also assessed the certainty of the evidence for adverse event data related to the implant, fracture, or both, in which effect estimates clearly indicated an improvement or risk with one treatment over another.

RESULTS

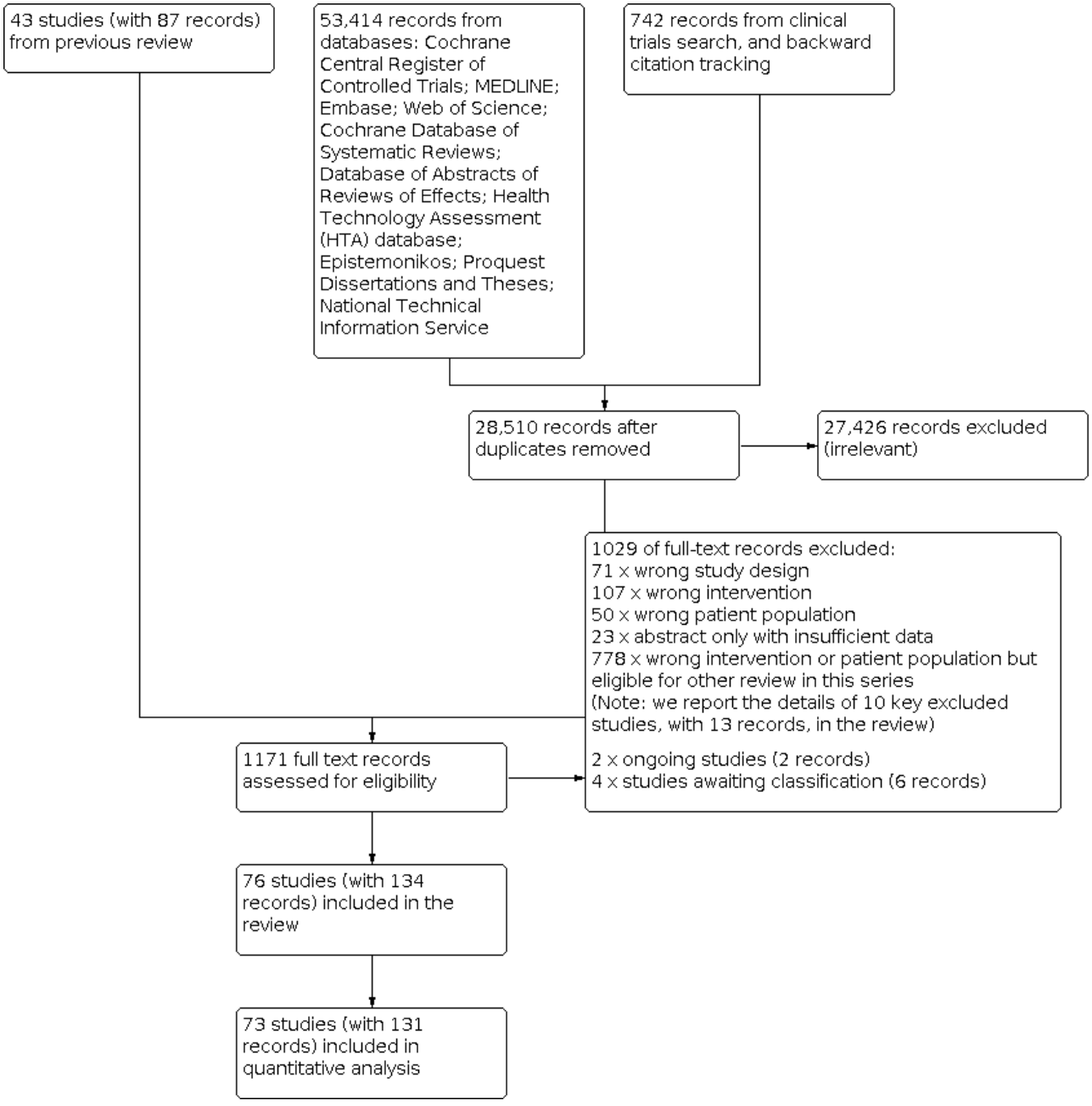
Description of studies

See Characteristics of included studies, Characteristics of excluded studies, and Characteristics of ongoing studies.

Results of the search

After the removal of duplicates from the search results, we screened 28,510 titles and abstracts, which included backward citation searches and searches of clinical trials registers. We excluded 27,426 irrelevant records. We reviewed the full text of 1171 records, and because of minor changes to the review criteria, this included studies in Parker 2010. We excluded 1029 records, and report the details of 10 key studies from these records. We included 76 studies (with 134 records) and identified two ongoing studies; we incorporated 34 new studies in the review. Four studies are awaiting classification. See Figure 1.

Figure 1. Flow diagram. Search conducted in November 2018 and December 2018, with a top-up search in July 2020.



Included studies

Types of studies and setting

We included 76 studies (see Characteristics of included studies). Five studies were reported only as abstracts in which only limited study characteristics were reported (Benum 1994; Mehdi 2000; Michos 2001; Mott 1993; Raimondo 2012). Ten studies used methods to allocate participants to interventions which we assessed to be quasi-randomised (Butt 1995; Goldhagen 1994; Guyer 1991; Hardy 1998; Leung 1992; Lopez 2002; Park 1998; Sharma 2018; Verettas 2010; Yamauchi 2014). The earliest study was reported in 1988 and the latest in 2020; 47% of the studies were completed from 2010 onwards.

Eleven studies were conducted across multiple centres (Ahrengart 1994; Andalib 2020; Baumgaertner 1998; Benum 1994; Davis 1988; Ekstrom 2007; Matre 2013; Mott 1993; Rahme 2007; Reindl 2015; Sanders 2017). Twelve studies were completed in the UK (Adams 2001; Barton 2010; Bridle 1991; Butt 1995; Davis 1988; Harrington 2002; Haynes 1996; Little 2008; Mehdi 2000; Parker 2012; Parker 2017; Radford 1993); twelve in China (Cai 2016; Chen 2018; Gou 2013; Han 2012; Li 2018; Song 2011; Tao 2013; Wang 2019; Xu 2010; Xu 2018; Zhou 2012; Zou 2009); five in Greece (Aktselis 2014; Kouvidis 2012; Michos 2001; Papasimos 2005; Verettas 2010); four in Switzerland (Guyer 1991; Pelet 2001; Sadowski 2002; Saudan 2002); three each in Canada (O'Brien 1995; Reindl 2015; Sanders 2017), India (Haq 2014; Singh 2017; Singh 2019), Spain (Lopez 2002; Utrilla 2005; Varela-Egocheaga 2009), Sweden (Ahrengart 1994; Ekstrom 2007; Mehdi 2000) and the USA (Baumgaertner 1998; Goldhagen 1994; Mott 1993); and two each in Brazil (Guerra 2014; Sharma 2018), France (Dujardin 2001; Giraud 2005), Italy (Carulli 2017; Raimondo 2012), Japan (Kuwabara 1998; Yamauchi 2014), Norway (Benum 1994; Matre 2013), Pakistan (Adeel 2020; Akhtar 2016), South Korea (Hong 2011; Park 1998) and Turkey (Eceviz 2020; Zehir 2015). The remainder took place in European countries (Hardy 1998; Hoffmann 1999; Kukla 1997; Ovesen 2006; Pahlpatz 1993; Pajarinen 2005) or Australia (Rahme 2007), Hong Kong (Leung 1992), Iran (Andalib 2020), Israel (Chechik 2014), Mexico (Calderon 2013) or New Zealand (Hoffman 1996).

Types of participants

In total 10,979 participants with 10,998 hip fractures were recruited across the 76 studies. Of the included studies, 43 specified a lower age limit for participant inclusion; one only accepted participants older than 70 years (Verettas 2010); 13 used 65 years as the lower limit (Aktselis 2014; Cai 2016; Eceviz 2020; Guerra 2014; Harrington 2002; Kouvidis 2012; Kuwabara 1998; Leung 1992; Tao 2013; Utrilla 2005; Xu 2010; Xu 2018; Zehir 2015); 17 used 60 years (Bridle 1991; Calderon 2013; Chechik 2014; Chen 2018; Dujardin 2001; Gou 2013; Han 2012; Hardy 1998; Hong 2011; Kukla 1997; Li 2018; Matre 2013; Papasimos 2005; Radford 1993; Singh 2019; Song 2011; Varela-Egocheaga 2009); four used 55 years (Reindl 2015; Sadowski 2002; Sanders 2017; Saudan 2002); two used 50 years (Davis 1988; Hoffman 1996) and 40 years (Adeel 2020; Akhtar 2016); four used 18 years (Barton 2010; Haq 2014; Sharma 2018; Singh 2017) and one used 16 years (Pelet 2001). The studies with 18 and 16 years as a lower cut-off reported a mean age which reassured us that the study population was representative of the age group under investigation in this review. Three studies reported an upper age limit for participants; these were 70 years (Akhtar 2016), 75 years (Adeel 2020) and 90 years (Calderon 2013). The mean age for all participants was greater than 70 years of age in 82% of included studies. Three studies had a mean age less than 60 years of age (Akhtar 2016; Haq 2014; Singh 2017). Five studies did not report the age of participants (Ahrengart 1994; Goldhagen 1994; Han 2012; Pahlpatz 1993; Reindl 2015).

Gender was reported in 70 studies; overall, 72% of participants were female. Twelve studies specified in their inclusion criteria that participants should have been able to walk prior to surgery (Akhtar 2016; Andalib 2020; Cai 2016; Eceviz 2020; Guerra 2014; Kukla 1997; Papasimos 2005; Reindl 2015; Sanders 2017; Xu 2010; Yamauchi 2014; Zehir 2015). Nine studies excluded participants with cognitive impairment (Chechik 2014; Chen 2018; Eceviz 2020; Harrington 2002; Li 2018; Parker 2012; Reindl 2015; Wang 2019; Yamauchi 2014) and 55% of the studies excluded pathological fractures.

Most studies included participants with trochanteric fractures; 12 studies also included subtrochanteric fractures (Benum 1994; Butt 1995; Ekstrom 2007; Goldhagen 1994; Guyer 1991; Haynes 1996; Leung 1992; Matre 2013; Michos 2001; Miedel 2005; Mott 1993; Pahlpatz 1993). Rahme 2007 included only subtrochanteric fractures, and Eceviz 2020 included only basicervical fractures. Three studies included only stable fractures (Cai 2016; Eceviz 2020; Sharma 2018) and 17 studies investigated unstable fractures (Adeel 2020; Akhtar 2016; Aktselis 2014; Andalib 2020; Barton 2010; Calderon 2013; Ekstrom 2007; Haq 2014; Harrington 2002; Miedel 2005; Papasimos 2005; Reindl 2015; Sadowski 2002; Singh 2017; Verettas 2010; Xu 2010; Zehir 2015). Two studies did not report fracture subtypes (Michos 2001; Raimondo 2012), and the remaining studies included both stable and unstable fractures.

Three studies included participants with a preoperative waiting in excess of two weeks (Haq 2014; Zehir 2015; Zhou 2012), two studies included patients with a wait of up to two weeks (Hong 2011; Reindl 2015), two studies reported a wait of seven days (Akhtar 2016; Tao 2013), four studies reported a mean waiting time of five days (Eceviz 2020; Singh 2017; Wang 2019; Yamauchi 2014), four studies had a mean of three days (Cai 2016; Kouvidis 2012; Rahme 2007; Song 2011) and 12 studies reported a waiting time of less than 48 hours (Adams 2001; Calderon 2013; Chechik 2014; Dujardin 2001; Goldhagen 1994; Haynes 1996; Hoffman 1996; Kukla 1997; O'Brien 1995; Pajarinen 2005; Sanders 2017; Verettas 2010). The remaining 49 studies did not report the preoperative waiting time.

Types of interventions

All studies used two-arm designs, except for Papasimos 2005 which compared two cephalomedullary nails and an extramedullary implant.

Cephalomedullary implants

We included a number of different cephalomedullary nails in this review. Twenty-nine studies reported outcomes of the Gamma nail (Adams 2001; Ahrengart 1994; Aktselis 2014; Barton 2010; Benum 1994; Bridle 1991; Butt 1995; Goldhagen 1994; Guyer 1991; Han 2012; Haynes 1996; Hoffman 1996; Kukla 1997; Kuwabara 1998; Leung 1992; Lopez 2002; Michos 2001; Miedel 2005; Mott 1993; O'Brien 1995; Ovesen 2006; Pahlpatz 1993; Park 1998; Pelet 2001; Radford 1993; Reindl 2015; Song 2011; Utrilla 2005; Verettas 2010). One study specified a Gamma 3 nail (Varela-Egocheaga 2009). A proximal femoral nail (PFN) was used in 12 studies (Adeel 2020; Calderon 2013; Ekstrom 2007; Guerra 2014; Haq 2014; Hong 2011; Pajarinen 2005; Rahme 2007; Sadowski 2002; Saudan 2002; Singh 2017; Singh 2019) and a further 13 used the proximal femoral nail antirotation (PFNA) (Akhtar 2016; Carulli 2017; Chen 2018; Gou 2013; Li 2018; Tao 2013; Wang 2019; Xu 2010; Xu 2018; Yamauchi 2014; Zehir 2015; Zhou 2012; Zou 2009). One study used an ultra-short PFN (Sharma 2018) and one described using an expandable PFN (Chechik 2014). Three studies specifically used a Targon PFN (Giraud 2005; Parker 2012; Parker 2017) and two studies used the TRIGEN INTERTAN nail (Matre 2013; Sanders 2017). Five used an intramedullary hip screw (IMHS) (Baumgaertner 1998; Hardy 1998; Harrington 2002; Hoffmann 1999; Mehdi 2000). One study used a mixture of Gamma nails and PFNs (Papasimos 2005). Holland nails and Küntscher-Y nails were used in one study each (Little 2008 and Davis 1988, respectively). Six studies reported a nonspecific intervention, describing the implant used

as a cephalomedullary or intramedullary nail (Andalib 2020; Cai 2016; Dujardin 2001; Eceviz 2020; Kouvidis 2012; Raimondo 2012). In Dujardin 2001, the nail was described as an experimental device that is not commercially available.

Two studies used long cephalomedullary nails (Barton 2010; Little 2008), and 20 studies used mixed nail lengths or the length of the nail was unknown (Adeel 2020; Akhtar 2016; Calderon 2013; Chechik 2014; Davis 1988; Hong 2011; Kuwabara 1998; Li 2018; Lopez 2002; Matre 2013; Michos 2001; Mott 1993; O'Brien 1995; Pahlpatz 1993; Pelet 2001; Rahme 2007; Raimondo 2012; Sanders 2017; Singh 2017; Singh 2019). The remaining studies used short nails. Twelve studies reported using double femoral head screws (Dujardin 2001; Eceviz 2020; Ekstrom 2007; Giraud 2005; Haq 2014; Kouvidis 2012; Little 2008; Pajarinen 2005; Parker 2012; Parker 2017; Saudan 2002; Sharma 2018); three used a mixture of single and double femoral head screws (Andalib 2020; Papasimos 2005; Verettas 2010); one study used dual integrated screws (Sanders 2017); seven studies did not report the number of femoral head screws (Adeel 2020; Baumgaertner 1998; Calderon 2013; Guerra 2014; Rahme 2007; Sadowski 2002; Singh 2017); and the remaining studies used a single femoral head screw. Fourteen studies used blades rather than screws (Akhtar 2016; Carulli 2017; Gou 2013; Hong 2011; Li 2018; Singh 2019; Tao 2013; Wang 2019; Xu 2010; Xu 2018; Yamauchi 2014; Zehir 2015; Zhou 2012; Zou 2009) and two studies used a mixture of blades and screws (Andalib 2020; Reindl 2015). Distal locking was reported in 32% of studies, using one to two screws.

Nine studies reported using dynamic femoral head fixation (Bridle 1991; Eceviz 2020; Goldhagen 1994; Kouvidis 2012; Little 2008; Parker 2012; Parker 2017; Reindl 2015; Varela-Egocheaga 2009) and six reported static fixation (Chechik 2014; Davis 1988; Dujardin 2001; Singh 2019; Tao 2013; Wang 2019). The remaining studies did not report whether femoral head screw fixation was static or dynamic. One study described the implant as an experimental nail (Dujardin 2001).

Extramedullary implants

Seven studies reported using static extramedullary plates (Han 2012; Haq 2014; Pelet 2001; Rahme 2007; Singh 2017; Tao 2013; Zhou 2012); the remainder all used dynamic plates. The implants were described as either dynamic hip screws (Adeel 2020; Bridle 1991; Butt 1995; Calderon 2013; Carulli 2017; Giraud 2005; Guerra 2014; Guyer 1991; Haynes 1996; Hoffmann 1999; Hong 2011; Kukla 1997; Leung 1992; O'Brien 1995; Ovesen 2006; Pahlpatz 1993; Pajarinen 2005; Radford 1993; Reindl 2015; Saudan 2002; Sharma 2018; Singh 2019; Song 2011; Verettas 2010; Wang 2019; Xu 2010; Xu 2018; Yamauchi 2014; Zehir 2015; Zou 2009), sliding hip screws (Barton 2010; Baumgaertner 1998; Davis 1988; Dujardin 2001; Eceviz 2020; Lopez 2002; Mehdi 2000; Michos 2001; Mott 1993; Parker 2012; Parker 2017; Sanders 2017), AMBI hip screws (Hoffman 1996; Kouvidis 2012; Papasimos 2005), compression hip screws (Adams 2001; Ahrengart 1994; Aktselis 2014; Benum 1994; Chechik 2014; Goldhagen 1994; Hardy 1998; Harrington 2002; Kuwabara 1998; Little 2008; Park 1998; Utrilla 2005), Less Invasive Stabilization System plate (LISS) (Tao 2013; Zhou 2012), Medoff sliding plate (Ekstrom 2007; Mehdi 2000), blade plates (Li 2018; Pelet 2001; Rahme 2007), percutaneous compression plates (Gou 2013; Singh 2017), dynamic condylar screws (Akhtar 2016; Sadowski 2002) or locking compression plates (Han 2012; Singh 2017). One study used a mixture of dynamic hip screws and dynamic condylar screws (Andalib 2020). In another study, the type of extramedullary device was not explicitly stated but from information within the report we assume that a dynamic hip screw was used (Cai 2016).

Types of outcome measures

Three studies reported no review outcomes (Akhtar 2016; Song 2011; Wang 2019). All other studies reported data contributing to the critical outcomes in the review, except Hong 2011 and Mehdi 2000; these two studies reported adverse events related to the implant, index fracture, or both.

Sources of funding and declarations of interest

Study authors reported no conflicts of interest in 45% of studies. Five studies received industry funding (Hardy 1998; Haynes 1996; Matre 2013; Miedel 2005; Sanders 2017). The remaining studies did not report sources of funding or any potential conflicts of interest.

Excluded studies

Studies previously excluded are reported in Parker 2010. Here, we report the details of 10 key excluded studies (see Characteristics of excluded studies). Lee 2007 included only participants younger than 55 years of age. This study was included in a previous version of the review (Parker 2010); we have since changed the review criteria to include adults older than 60 years, and therefore Lee 2007 is no longer eligible (see Differences between protocol and review). We excluded Stern 2011 because this study was designed to compare screws and helical blades and the cephalomedullary nails and extramedullary implants were used in both intervention groups. We excluded two studies because they were reported only as abstracts with insufficient detail to allow inclusion (Ahmad 2011; Gupta 2012). We excluded six clinical trial reports. Two of these were terminated early and have not published findings (ACTRN12608000162314; NCT03065101). Four were completed in 2011/2012, according to the clinical trials register; we excluded these because we expect publication of findings is now unlikely (NCT00686023; NCT00736684; NCT01173744; NCT01238068).

Studies awaiting classification

We received confirmation that three studies have been completed but have not yet published and data were not currently available; these have been categorised as awaiting classification (NCT02788994; NCT01380444; NCT03849014). We also identified a fourth study which appears to be the pilot study of NCT01380444 (REGAIN 2008). It is anticipated that these studies will have an estimated number of participants totalling 856. They are investigating the Endovis intermedullary nail, PFN and Gamma 3 nail, in comparison to SHS. See Characteristics of studies awaiting classification.

Ongoing studies

We found two ongoing studies (IRCT20141209020258N80; NCT03906032). Both studies compare a PFN and dynamic hip screw (DHS). These studies have an estimated enrolment of 388 participants. See Characteristics of ongoing studies.

Risk of bias in included studies

We only completed risk of bias assessments for studies that reported outcome data of interest to this review. We assessed detection bias separately for subjective and objective measures.

Blank spaces in the risk of bias figure indicate that risk of bias assessment was not completed for the study or for the particular domain. See Figure 2.

Figure 2. 'Risk of bias' summary: review authors' judgements about each risk of bias item for each included study. Blank spaces in the figure indicate that 'Risk of bias' judgements were not made because study authors did not report data for these outcomes.

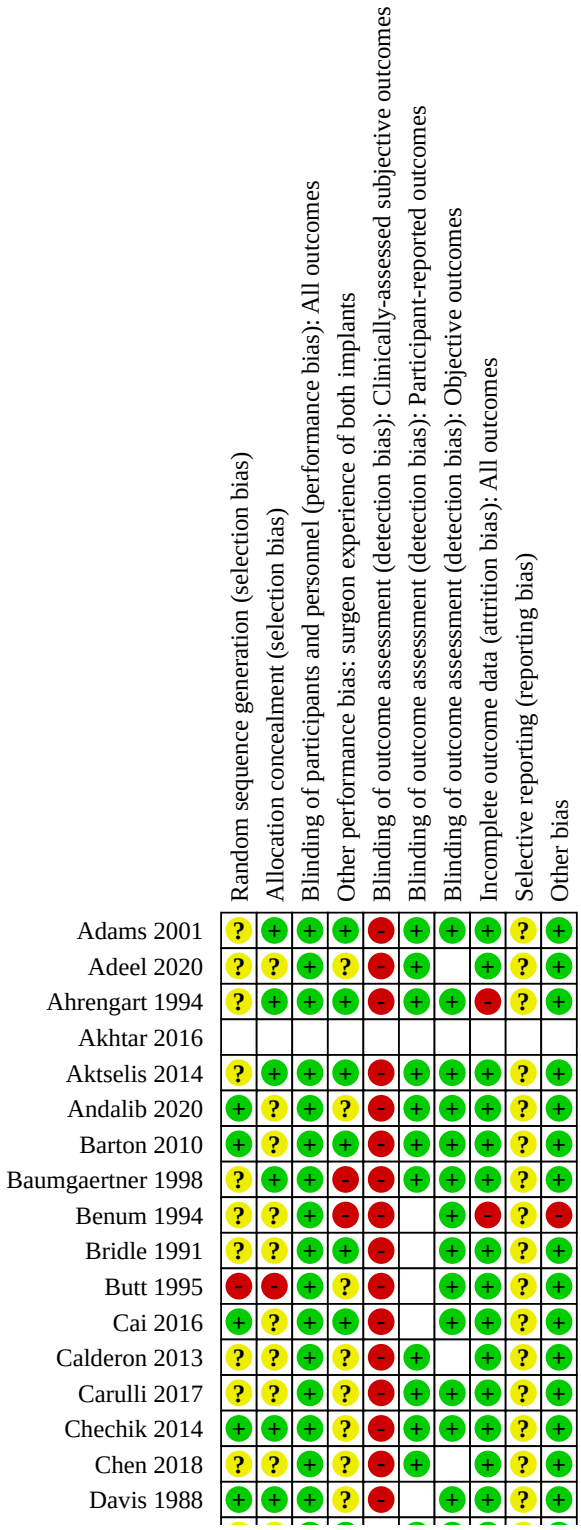


Figure 2. (Continued)

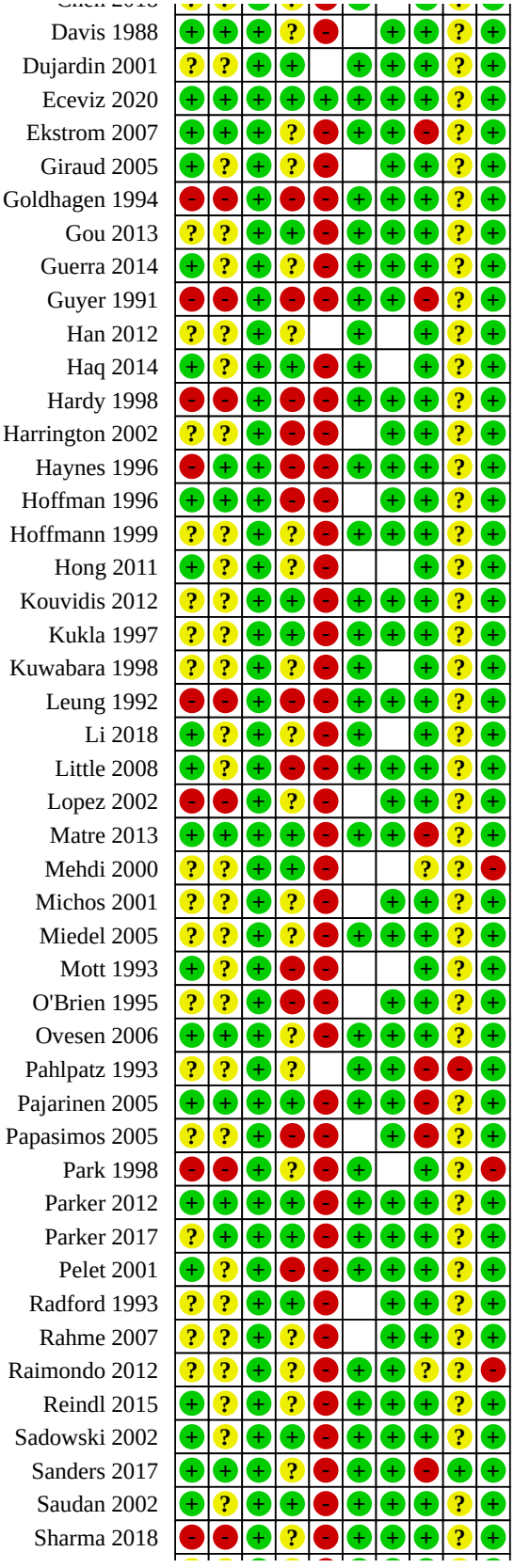
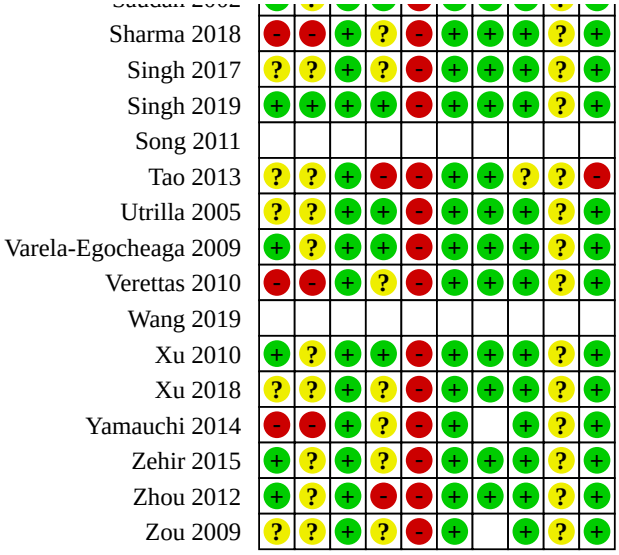


Figure 2. (Continued)



Allocation

Twenty-nine studies described adequate methods to randomise participants to treatment groups, and we judged these studies to be at low risk of selection bias for sequence generation (Andalib 2020; Barton 2010; Cai 2016; Chechik 2014; Davis 1988; Eceviz 2020; Ekstrom 2007; Giraud 2005; Guerra 2014; Haq 2014; Hoffman 1996; Hong 2011; Li 2018; Little 2008; Matre 2013; Mott 1993; Ovesen 2006; Pajarinen 2005; Parker 2012; Pelet 2001; Reindl 2015; Sadowski 2002; Sanders 2017; Saudan 2002; Singh 2019; Varela-Egocheaga 2009; Xu 2010; Zehir 2015; Zhou 2012). Of these, 11 studies also reported an adequate method of concealment, and we judged these to also have a low risk of selection bias for allocation concealment (Chechik 2014; Davis 1988; Eceviz 2020; Ekstrom 2007; Hoffman 1996; Matre 2013; Ovesen 2006; Pajarinen 2005; Parker 2012; Sanders 2017; Singh 2019). Five studies reported an adequate method of allocation concealment but did not report methods for randomisation (Aktselis 2014; Adams 2001; Ahrengart 1994; Baumgaertner 1998; Parker 2017).

We judged 10 quasi-randomised studies to be at high risk of selection bias (sequence generation) owing to the methods used to allocate participants to treatment groups (Butt 1995; Goldhagen 1994; Guyer 1991; Hardy 1998; Leung 1992; Lopez 2002; Park 1998; Sharma 2018; Verettas 2010; Yamauchi 2014). Similarly, we also judged allocation concealment to be at high risk of bias in these studies. Although Haynes 1996 reported an appropriate method of sequence generation (described as using "randomisation cards"), which could be adequately concealed, we judged the risk of selection bias for sequence generation to be high; the study reports that some surgeons may have omitted participants from the study if a card was drawn for 'Gamma nails', due to unfamiliarity with intramedullary nailing technique.

The remaining studies did not report methods for randomisation or methods used to conceal allocation. We therefore judged the risk of bias as unclear in both domains.

Blinding

It is not possible to blind clinicians to the types of surgical interventions reported in this review. However, we did not expect that surgeons' performance would be influenced by the lack of blinding, and we judged all studies to be at low risk of performance bias related to blinding.

We expected, however, that surgeons' experience in using the implants could influence their performance. We extracted descriptions in the study report that either directly described that surgeons did not have comparable experience with both types of implants in their study (Baumgaertner 1998; Guyer 1991; Harrington 2002; Haynes 1996; Leung 1992; Pelet 2001; Tao 2013), or that indirectly inferred evidence of a learning curve or similar (Benum 1994; Goldhagen 1994; Hardy 1998; Hoffman 1996; Little 2008; Mott 1993; O'Brien 1995; Papasimos 2005; Zhou 2012); we judged these 16 studies to be at high risk of performance bias related to surgeon experience. We judged 24 studies to be at low risk of performance bias related to surgeon experience because surgeons were equally experienced with each type of implant under investigation (Adams 2001; Ahrengart 1994; Aktselis 2014; Barton 2010; Bridle 1991; Cai 2016; Dujardin 2001; Eceviz 2020; Gou 2013; Haq 2014; Kouvidis 2012; Kukla 1997; Matre 2013; Mehdi 2000; Pajarinen 2005; Parker 2012; Parker 2017; Radford 1993; Sadowski 2002; Saudan 2002; Singh 2019; Utrilla 2005; Varela-Egocheaga 2009; Xu 2010). The remaining studies reported insufficient detail and the risk of performance bias related to surgeon experience was unclear.

For detection bias, we considered whether outcomes were assessed by clinicians or participants, and whether assessment of these measures was likely to involve a subjective decision. We judged mortality to be an objective measure, and judged risk of detection bias to be low for all studies that measured this outcome. Although studies mostly did not describe whether participants were aware of treatment allocation, we judged the risk of detection

bias to be low for subjective outcomes that were participant-reported. However, we expected that all other clinically-assessed outcomes were at high risk of detection bias because clinicians or other outcome assessors were likely to be aware of the type of treatment used.

Incomplete outcome data

For attrition bias, we considered whether study authors clearly reported participant losses, whether losses were balanced between study groups, and whether the reasons for losses seemed acceptable. We noted that most losses were caused by death and, because of the typical age of participants in these studies, we were not concerned by these losses.

In nine studies, we noted that a high number of losses were not clearly explained or were explained for reasons other than death, for example, because of loss to follow-up (Ahrengart 1994; Benum 1994; Ekstrom 2007; Guyer 1991; Matre 2013; Pahlpatz 1993; Pajarinen 2005; Papasimos 2005; Sanders 2017). We judged these studies to be at high risk of attrition bias. Risk of attrition bias was unclear in three studies, and this was because of limited information reported in the abstract (Mehdi 2000; Raimondo 2012), and because the number of participants randomised to each group was not reported (Tao 2013).

Selective reporting

We assessed only one study to be at low risk of selective reporting bias (Sanders 2017); this study was prospectively registered with a clinical trials register and the outcomes reported in the study report were consistent with those listed in the register. Five studies were retrospectively registered with a clinical trials register, and it was not possible to use these register documents to effectively assess risk of selective reporting bias (Barton 2010; Cai 2016; Eceviz 2020; Parker 2017; Reindl 2015). We identified one clinical trials register report and could not be certain whether the report was linked to one of our included studies because of some discrepancies in the report, and we judged risk of selective reporting bias for this study to be also unclear (Chechik 2014).

Because the remaining studies did not report clinical trials registration or a prepublished protocol, it was not possible to assess risk of selective reporting bias, and we therefore judged risk of selective reporting bias in these studies to also be unclear.

Other potential sources of bias

We judged three studies to be at high risk of bias because they were reported only as abstracts which we expected were not peer-reviewed; in addition, we could not be certain of other potential sources of bias because of the limited detail in the reports (Benum 1994; Mehdi 2000; Raimondo 2012). We noted differences in patient management between study groups in Tao 2013 and Park 1998, in particular related to the time before weight-bearing was allowed; because this could influence the data we judged the risk of other bias to be high in these studies. We identified no other potential sources of bias in the remaining studies.

Effects of interventions

See: **Summary of findings 1** Cephalomedullary nails compared to extramedullary implants for extracapsular hip fractures in adults

We summarise which studies are included in each analysis in Appendix 3. For outcomes measured with scales, we present the range of scores and direction of effect for each scale in Appendix 4.

We used GRADE to assess the certainty of the evidence for the critical outcomes measured within four months of surgery (activities of daily living (ADL), functional status, health-related quality of life, and mobility), within four months and at 12 months for mortality, and at the end of follow-up for delirium and unplanned return to theatre). For outcomes assessed using more than one measurement, we graded the evidence for the outcome with most studies or participants. See Summary of findings 1.

We summarise the effects of other important review outcomes in a table and report the results here only when there was evidence of a difference between the interventions. No subgroup or sensitivity analyses are reported for these outcomes. We have presented GRADE assessments for adverse events that clearly favoured one treatment; we did not complete GRADE assessments for other important outcomes.

Critical outcomes

Activities of daily living

Within four months of surgery, we found the following.

- We did not pool studies for the performance of ADL within four months because statistical heterogeneity was substantial (I^2 = 91%); see Analysis 1.1 for data from these individual studies. This outcome was measured using the Lower Extremity Measure (LEM), the Functional Independence Measure (FIM), and the Japanese Orthopaedic Association (JOA) score; higher scores in all scales indicate better performance of ADL. The studies reported these data at four weeks (Yamauchi 2014), and three months (Andalib 2020; Reindl 2015; Sanders 2017). The certainty of this evidence was very low; we downgraded by one level for serious risks of bias and by two levels for inconsistency owing to substantial levels of statistical heterogeneity.
- Miedel 2005 reported the number of participants who were independent in the performance of ADL; the estimate was imprecise but suggested little evidence of a difference between interventions (RR 0.82, 95% CI 0.62 to 1.08, favours extramedullary implants; 1 study, 168 participants; Analysis 1.2).
- Pahlpatz 1993 reported change in levels of independence using the Broos scale at three months. These data are reported in Appendix 5.
- In addition, Aktselis 2014 reported early performance in ADL using the Barthel Index. We did not calculate an effect estimate because the number of analysed participants was unclear. See Appendix 6 for mean scores as reported by study authors.

At 12 months after surgery, we found the following.

- The effect estimate for the performance of ADL was imprecise but provided evidence of little difference between interventions (SMD 0.01, 95% CI -0.26 to 0.27, favours cephalomedullary implants; 8 studies, 835 participants; I^2 = 70%; Analysis 1.4). The outcome was measured using the Barthel Index, FIM, LEM, and Jensen's scoring system; we inverted the data for the Jensen's score so that higher scores in all scales in the analysis indicate better performance in ADL. All data were reported at 12 months.

- Miedel 2005 also reported the number of participants who were independent in the performance of ADL at 12 months. Again, the estimate was imprecise but suggested little evidence of a difference between interventions (RR 0.90, 95% CI 0.70 to 1.16, favours extramedullary implants; 1 study, 156 participants; Analysis 1.5).
- Pahlpatz 1993 reported change in levels of independence using the Broos scale at six months and we reported these data in Appendix 5.

Delirium

The data for delirium indicated little evidence of a difference between implants, but this estimate was imprecise (RR 1.22, 95% CI 0.67 to 2.22, favours extramedullary implants; 5 studies, 1310 participants; I^2 = 0%; low-certainty evidence; Analysis 1.7). Delirium was described in the studies as acute psychosis (Hoffmann 1999), mental disturbances (Papasimos 2005), confusion/delirium (Parker 2012; Parker 2017) and disorientation (Varela-Egocheaga 2009). Time points were not clearly specified in studies; overall study follow-up ranged from four months to 12 months. We downgraded the GRADE assessment by one level for serious risks of bias, and one level owing to imprecision denoted by the wide CI in this estimate.

Functional status

Within four months of surgery, we found the following.

- We found little evidence of a difference in functional status, although the estimate was imprecise (SMD 0.02, 95% CI -0.27 to 0.30; 2 studies, 188 participants, favours cephalomedullary implants; I^2 = 0%; low-certainty evidence; Analysis 1.8). This outcome was measured using Zűckerman functional recovery scores and a 100-point functional recovery score; for both scales, higher scores indicate better functional status. Using the Zűckerman functional recovery, this effect estimate equates to a MD of 0.22, which is unlikely to be a clinically important difference. The studies reported these data at three months (Guerra 2014) and four months (Kouvidis 2012). We downgraded the certainty of the evidence by one level for serious risks of bias and one level for imprecision as the CI included both clinically relevant benefits and harms.
- We noted similar findings when this outcome was measured as the proportion of participants with excellent or good functional status (RR 1.04, 95% CI 0.96 to 1.13, favours cephalomedullary implants; 2 studies, 188 participants; I^2 = 0%; Analysis 1.9). This was measured using the Harris Hip Score (HHS) and the scoring system by D'Aubigne 1954; see Appendix 5 for all categories of these scoring systems in these two studies. This was reported at three months (Xu 2018), and three to four months (Hoffmann 1999).
- In addition, Raimondo 2012 reported early functional status using the HHS. We did not calculate an effect estimate because the number of analysed participants was unclear. See Appendix 6 for mean scores as reported by study authors.

At 12 months after surgery, we found the following.

- We did not pool studies for functional status at 12 months because statistical heterogeneity was substantial (I^2 = 94%); see Analysis 1.10 for data from these individual studies. This outcome was measured using the Zűckerman functional recovery score, HHS and modified HHS, Oxford Hip Score (OHS), and a 100-point functional recovery score which is not defined. For all scales, higher scores indicate better function. Data were reported at 16 months (Gou 2013), 18 months (Li 2018), 24 months (Singh 2017), and at 12 months in all the other studies.
- This outcome was also measured as the number of participants with excellent or good functional status using the HHS score, the Sanders scoring system and the Salvati and Wilson scoring system. We found little evidence of a difference between intervention groups and the estimate was imprecise, including clinically relevant benefits and harms (RR 1.06, 95% CI 0.89 to 1.27, favours cephalomedullary implants; 3 studies, 257 participants; I^2 = 67%; Analysis 1.11). The data for other categories of these scoring systems in these studies is in Appendix 5.
- In addition, Raimondo 2012 reported functional status at 12 months using the HHS. We did not calculate an effect estimate because the number of analysed participants was unclear. See Appendix 6 for mean scores as reported by study authors.

Health-related quality of life

Within four months of surgery, we found the following.

- Aktselis 2014 reported health-related quality of life using EQ-5D at three months, but we did not calculate an effect estimate because the number of analysed participants was unclear. See Appendix 6 for mean scores as reported by study authors; study authors reported a P value of 0.483 for their data.

At 12 months after surgery, we found the following.

- We found little evidence of a difference in health-related quality of life measured at 12 months in all studies using the physical component score (PCS) of SF-12 and using EQ-5D. The effect estimate included clinically relevant benefits and harms (SMD 0.28, 95% CI -0.15 to 0.71, favours cephalomedullary implants; 4 studies, 279 participants; I^2 = 65%; Analysis 1.12).

Mobility

Within four months of surgery, we found the following.

- We found that more people had independent mobility when a cephalomedullary implant was used (RR 1.12, 95% CI 1.01 to 1.23, favours cephalomedullary implants; 7 studies, 719 participants; I^2 = 0%; Analysis 1.13). This was measured at three months in three studies (Carulli 2017; Guyer 1991; Park 1998), and at four months in the remaining studies. The certainty of this evidence was deemed to be very low (for reasons, see below).
- We found little evidence of a difference in mobility scores when measured using the Parker 1993 mobility scale at three months (Parker 2012; Parker 2017) (MD 0.16, 95% CI -0.15 to 0.48, favours cephalomedullary implants; 2 studies, 695 participants; I^2 = 0%; Analysis 1.14); in this scale, higher scores indicate better mobility. In addition, two studies reported Parker mobility scores at six weeks (Eceviz 2020) and three months (Aktselis 2014). We did not calculate an effect estimate for these studies because the number of analysed participants was unclear and distribution values were not available. See Appendix 6 for mean scores as reported by study authors.
- We also found that performance in a 10-metre walking speed test, 14 days postoperatively, was improved for participants

with a cephalomedullary implant in Li 2018 (MD 0.70, 95% CI 0.63 to 0.77, favours cephalomedullary implants; 1 study, 80 participants; Analysis 1.15).

- Sanders 2017 reported this outcome as the proportion of participants who had sufficient ambulation to perform a Timed Up and Go test (TUG) at three months, and found little or no difference between interventions (RR 1.15, 95% CI 0.95 to 1.38, favours cephalomedullary implants; 1 study, 249 participants; Analysis 1.16).
- Reindl 2015 reported the time to complete a TUG at three months, with no evidence of a difference in number of seconds to complete this test (MD 0.00, 95% CI -5.93 to 5.93, favours cephalomedullary implants; 1 study, 167 participants; Analysis 1.17).
- For Analysis 1.13, we downgraded the evidence by three levels to very low certainty. We downgraded by two levels for serious risks of bias because all studies were at unclear risk of bias in at least domain, and in Park 1998 risk of other bias was high because of patient management differences between groups which could influence this outcome. We also downgraded by one level for inconsistency because we noted that effects were not consistent across the different measures of mobility at this time point; we therefore could not confidently draw conclusions about early mobility from these data.

At 12 months after surgery, we found the following.

- We found that participants with cephalomedullary implants had more improvement in mobility when measured using the Parker 1993 mobility scale (MD 0.48, 95% CI 0.10 to 0.87, favours cephalomedullary implants; 14 studies, 1746 participants; I^2 = 63%; Analysis 1.18). This outcome was measured at 10 months (Han 2012), 16 months (Gou 2013), 24 months (Singh 2017), and at 12 months in the remaining studies. We generated a funnel plot (Figure 3), and we found no statistical evidence of small-study effects (using Egger's test, P = 0.718).
- Barton 2010 measured this outcome using a five-point mobility scale according to the number of walking aids used, and reported as a change-from-baseline score. We found some evidence of a difference between intervention groups at 12 months, but the estimate was imprecise and included the possibility of little or no clinically relevant difference (MD 0.34, 95% CI -0.25 to 0.93, favours extramedullary implants; 1 study, 151 participants; Analysis 1.19).
- We found little evidence of a difference in the proportion of people who had independent mobility (RR 1.07, 95% CI 0.94 to 1.22, favours cephalomedullary implants; 12 studies, 1524 participants; I^2 = 33%; Analysis 1.20). Data were reported at six months in Goldhagen 1994, Haynes 1996, Kuwabara 1998 and Zehir 2015, and at 12 months in the remaining studies. We generated a funnel plot (Figure 4), and we found no statistical evidence of small-study effects (using the Harbord modified test, P = 0.656).
- Two studies reported the proportion of people who failed to regain their pre-fracture mobility, with little evidence of a difference between groups (RR 1.12, 95% CI 0.85 to 1.46, favours extramedullary implants; 2 studies, 246 participants; Analysis 1.23).
- Matre 2013 and Sanders 2017 reported this outcome as the proportion of participants who had sufficient ambulation to perform a TUG at 12 months. However, we did not pool this data because we noted substantial statistical heterogeneity (I^2 = 90%); see Analysis 1.21 for data from these individual studies.
- Reindl 2015 reported the time to complete a TUG at 12 months, with little evidence of a difference in the number of seconds to complete this test (MD -1.00, 95% CI -6.91 to 4.91, favours cephalomedullary implants; 1 study, 167 participants; Analysis 1.22).
- Kouvidis 2012 reported the number of participants who remained in bed, or in a wheelchair, with little evidence of a difference between interventions (RR 1.61, 95% CI 0.40 to 6.45, favours extramedullary implants; 1 study, 122 participants; Analysis 1.24).

Figure 3.

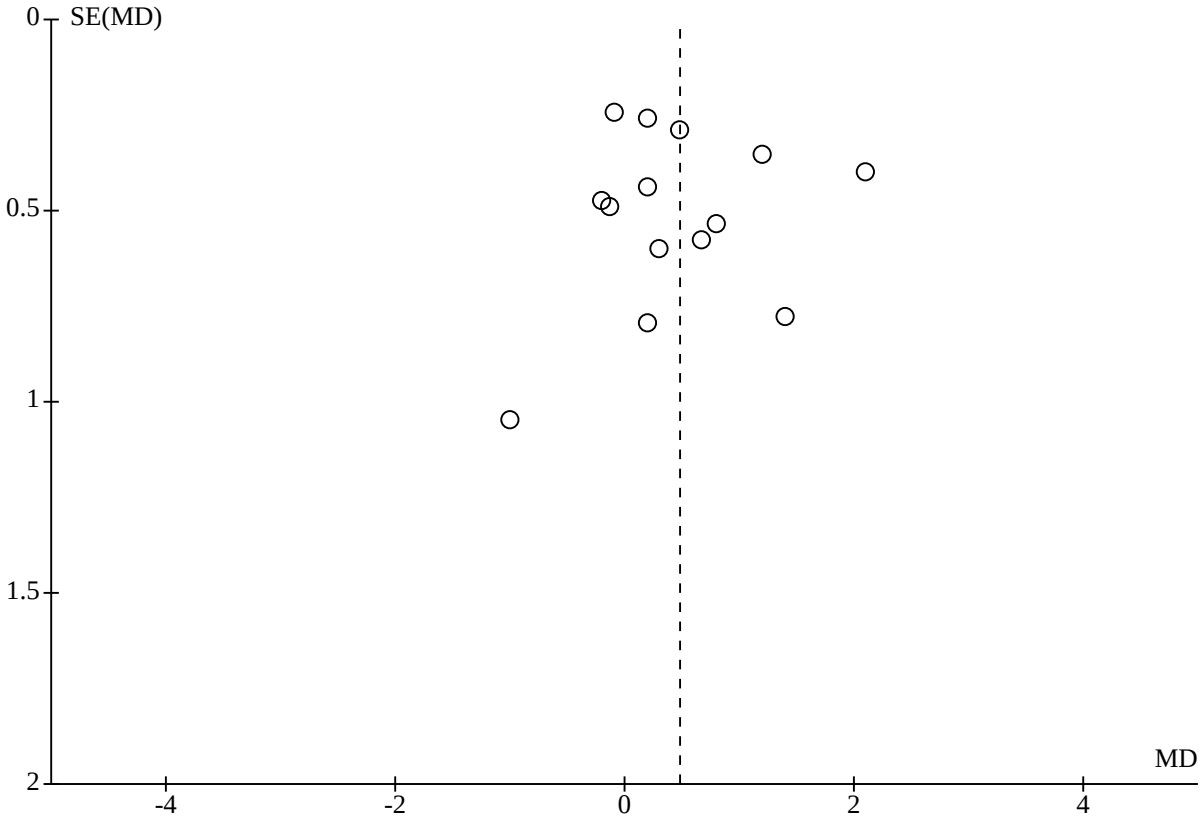
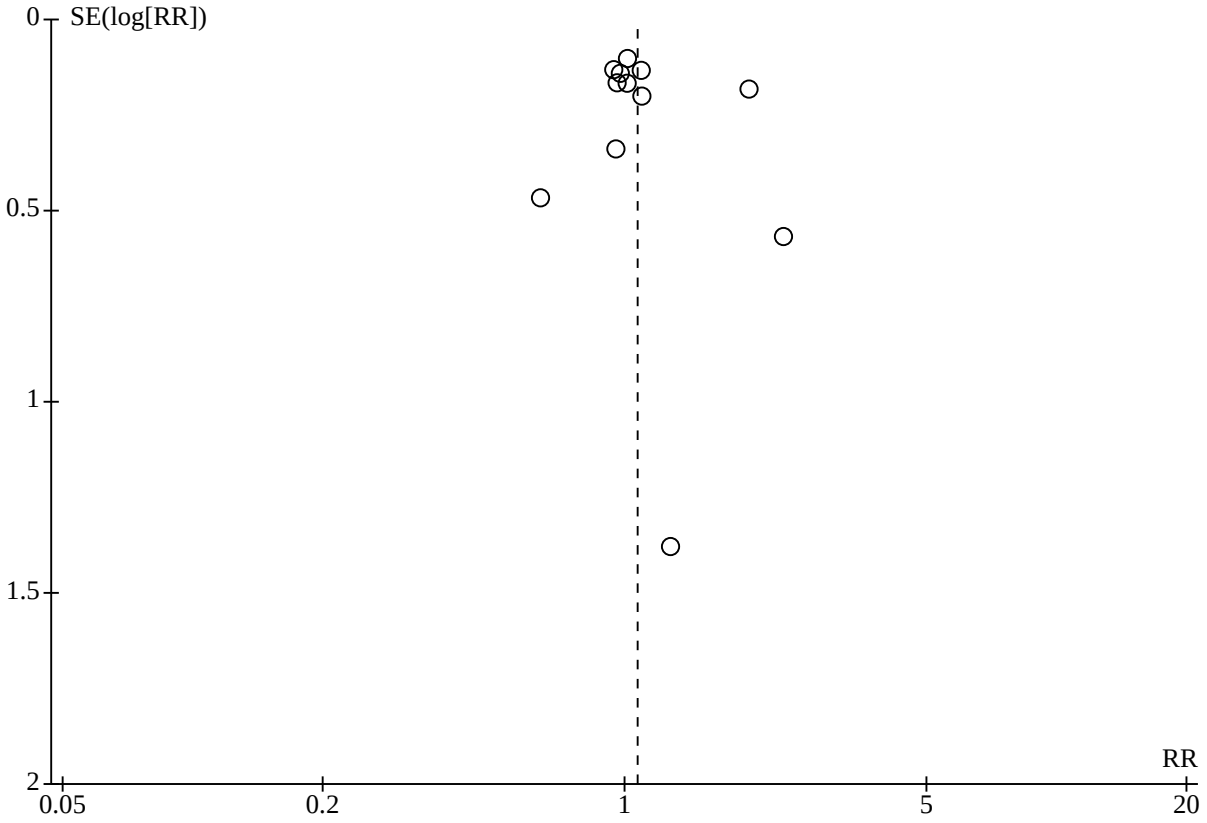


Figure 4.

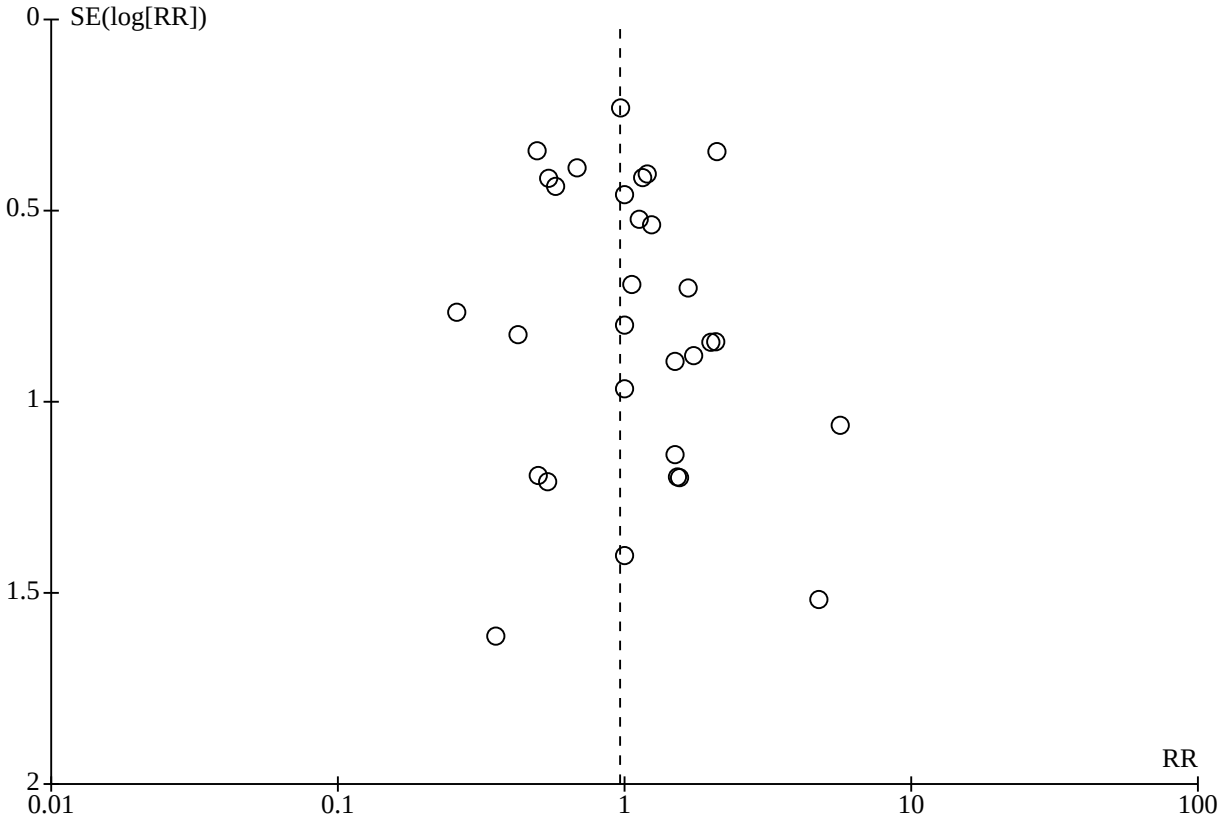


Mortality

Within four months of surgery, we found the following.

- We found little evidence of a difference in early mortality between the interventions, although the estimate was imprecise, including clinically relevant benefits and harms (RR 0.96, 95% CI 0.79 to 1.18, favours cephalomedullary implants; 30 studies, 4603 participants; I^2 = 0%; moderate-certainty evidence; Analysis 1.25). This outcome includes data reported during the early postoperative period, within hospital, and at one month, three months, and four months after surgery. We generated a funnel plot (Figure 5), and we found no statistical evidence of small-study effects (using the Harbord modified test, P = 0.390).
- We downgraded the evidence by one level because the evidence included studies with unclear and high risks of bias. We recognise that any benefit in this outcome is clinically meaningful for individuals who gain that benefit, such that a minimal clinically important difference for mortality is nonsensical. We also recognise that the estimate is based on data from 30 studies and 4603 participants; therefore we did not downgrade for imprecision.

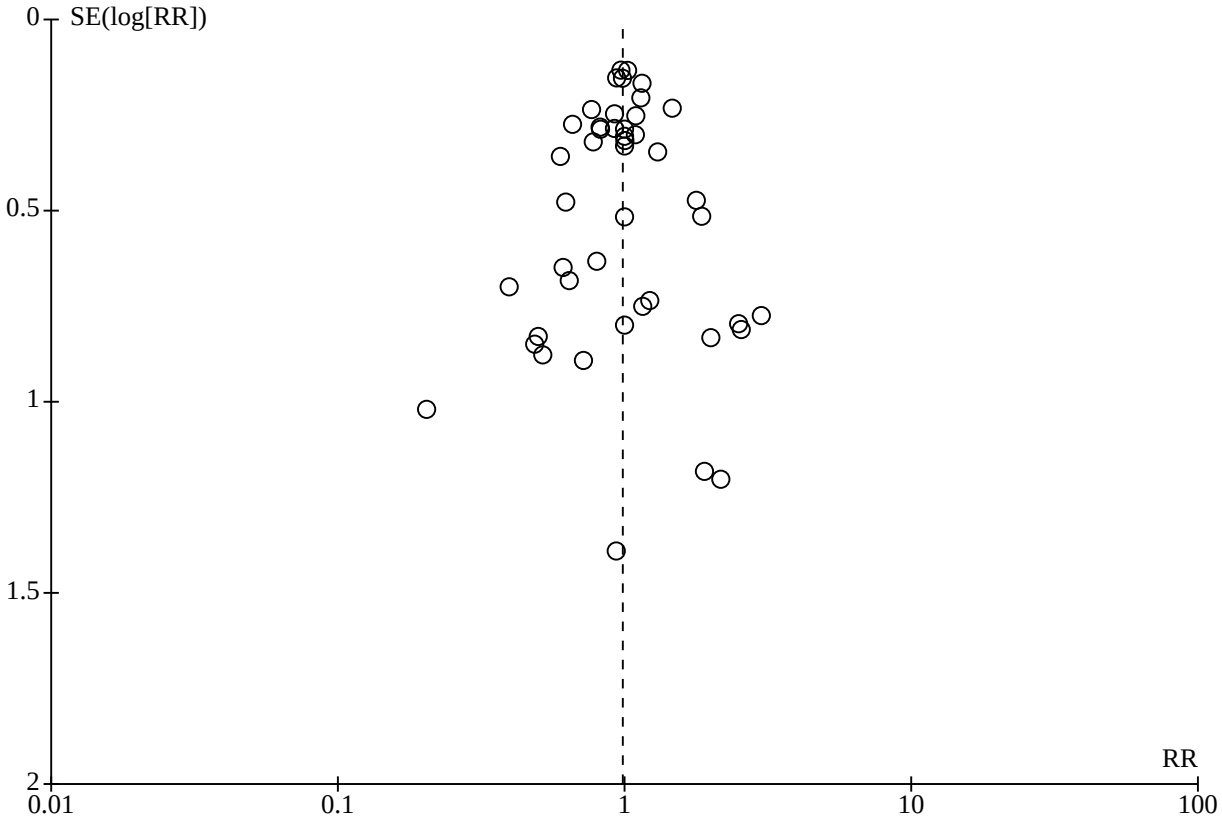
Figure 5.



At 12 months after surgery, we found the following.

- We found a similar estimate at the later time point (RR 0.99, 95% CI 0.90 to 1.08, favours cephalomedullary implants; 47 studies, 7618 participants; I^2 = 0%; moderate-certainty evidence; Analysis 1.26). Most studies reported this outcome at 12 months, but this analysis also includes data reported at five months (Butt 1995), six months (Ahrengart 1994; Bridle 1991; Dujardin 2001; Goldhagen 1994; Harrington 2002; Haynes 1996; Hoffman 1996; Kukla 1997; Leung 1992; Pahlpatz 1993; Singh 2019; Zhou 2012), 16 months (Zehir 2015), and 24 months (Gou 2013; Sharma 2018). We generated a funnel plot (Figure 6), and we found no statistical evidence of small-study effects (using the Harbord modified test, P = 0.817).
- As for the evidence for early mortality, we downgraded the certainty of this evidence by one level for risks of bias, and we did not downgrade for imprecision.

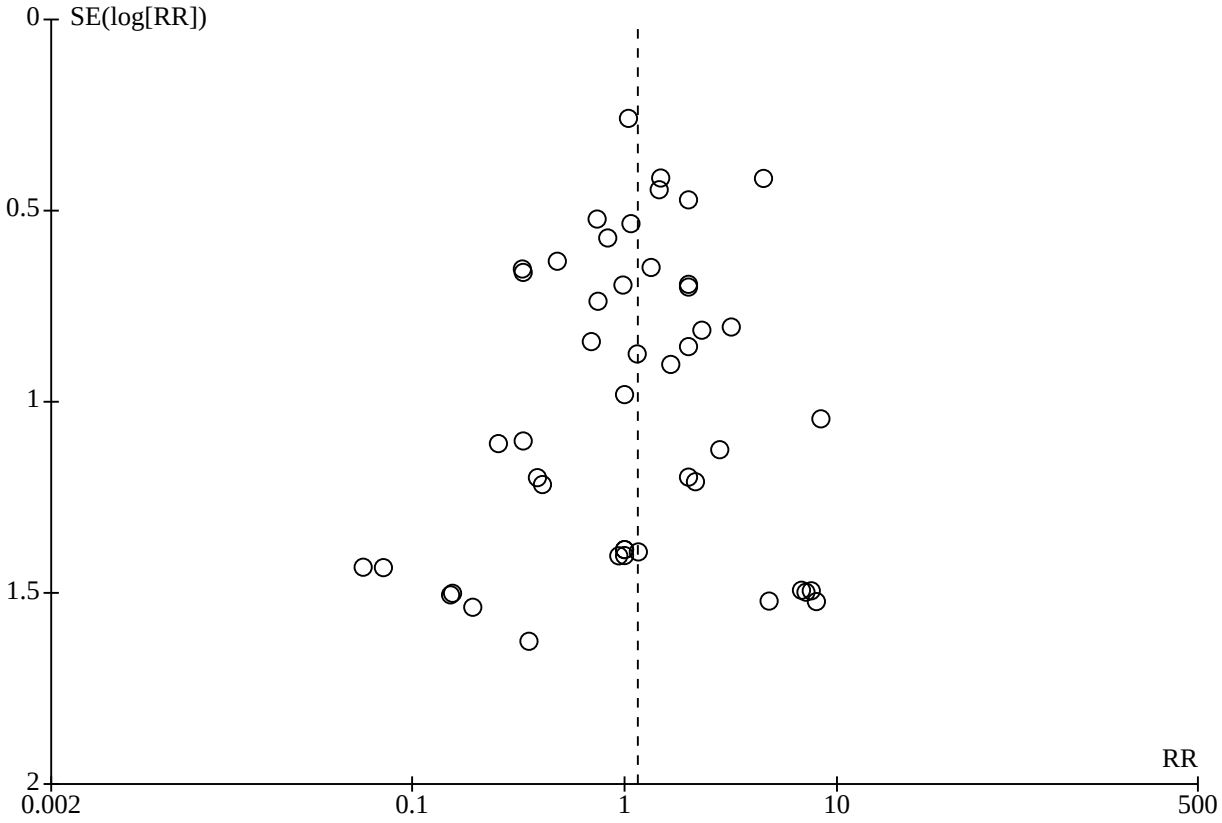
Figure 6.



Unplanned return to theatre

We found little evidence of a difference in unplanned return to theatre at the end of study follow-up according to the type of implant. The estimate was imprecise and included large clinically relevant benefits and harms (RR 1.15, 95% CI 0.89 to 1.50, favours extramedullary implants; 50 studies, 8398 participants; I^2 = 20%; low-certainty evidence; Analysis 1.27). Most studies reported this outcome at 12 months, but this analysis also included data reported at three months (Giraud 2005; Guyer 1991), four months (Hoffmann 1999; Pajarinen 2005), five months (Butt 1995), six months (Ahrengart 1994; Benum 1994; Goldhagen 1994; Haynes 1996; Hoffman 1996; Kukla 1997; Leung 1992), and approximately 24 months (Sharma 2018; Singh 2017; Zhou 2012). We generated a funnel plot (Figure 7), and found no statistical evidence of small-study effects (using the Harbord modified test, P = 0.372).

Figure 7.



We downgraded the certainty of the evidence by one level for serious risks of bias (all studies in this analysis were at high risk of detection bias) and one level for imprecision. The absolute risk of return to theatre was low in both groups (approximately 5%) and so despite a large sample of 8398 participants, the CI was wide.

Other important outcomes

We report the summary effects of important outcomes in Table 3. We found little or no difference in measures of pain scores or those experiencing pain within four months of surgery, and little or no difference in the number of people experiencing pain at 12 months. We did not pool data for measures of pain at 12 months because of substantial statistical heterogeneity which we could not explain. We also noted little or no difference in length of hospital stay or in discharge destination to own home or previous residence.

We report the summary effects of adverse effects related to the implant, index fracture, or both, in Table 4. We found fewer intraoperative periprosthetic fractures when extramedullary implants were used (RR 2.94, 95% CI 1.65 to 5.24; 35 studies, 4872 participants; I^2 = 0; moderate-certainty evidence), as well as fewer postoperative periprosthetic fractures (RR 3.62, 95% CI 2.07 to 6.33; 46 studies, 7021 participants; I^2 = 0%; moderate-certainty evidence). We noted that participants had fewer superficial infections with cephalomedullary implants (RR 0.71, 95% CI 0.53 to 0.96; 35 studies, 5087 participants; I^2 = 0%; moderate-certainty evidence), and there were fewer non-unions (RR 0.55, 95% CI 0.32 to 0.96; 40 studies, 4959 participants; I^2 = 0%; moderate-certainty evidence). For other adverse events related to the implant, fracture or both (loosening, cut-out, implant failure, and deep infection), we found little or no difference between interventions. See Table 4 and Analysis 1.34.

For adverse events unrelated to the implant, fracture, or both (acute kidney injury, blood transfusion, cerebrovascular accident, pneumonia, myocardial infarction, urinary tract infection, deep vein thrombosis, and pulmonary embolism), we found little or no difference between types of implants. See Table 5 and Analysis 1.35.

Subgroup analyses

We only conducted relevant subgroup analyses for outcomes with at least 10 studies. Overall, our analyses provided no evidence of subgroup effects between the length of cephalomedullary nail used, the stability of the fracture, or between newer and older designs of cephalomedullary nail. For a summary of the subgroup analyses, see Appendix 7. Subgroup analysis according to fracture stability for unplanned return to theatre is presented in Figure 8, and subgroup analysis according to the date of study publication for postoperative periprosthetic fractures is presented in Figure 9.

Figure 8.

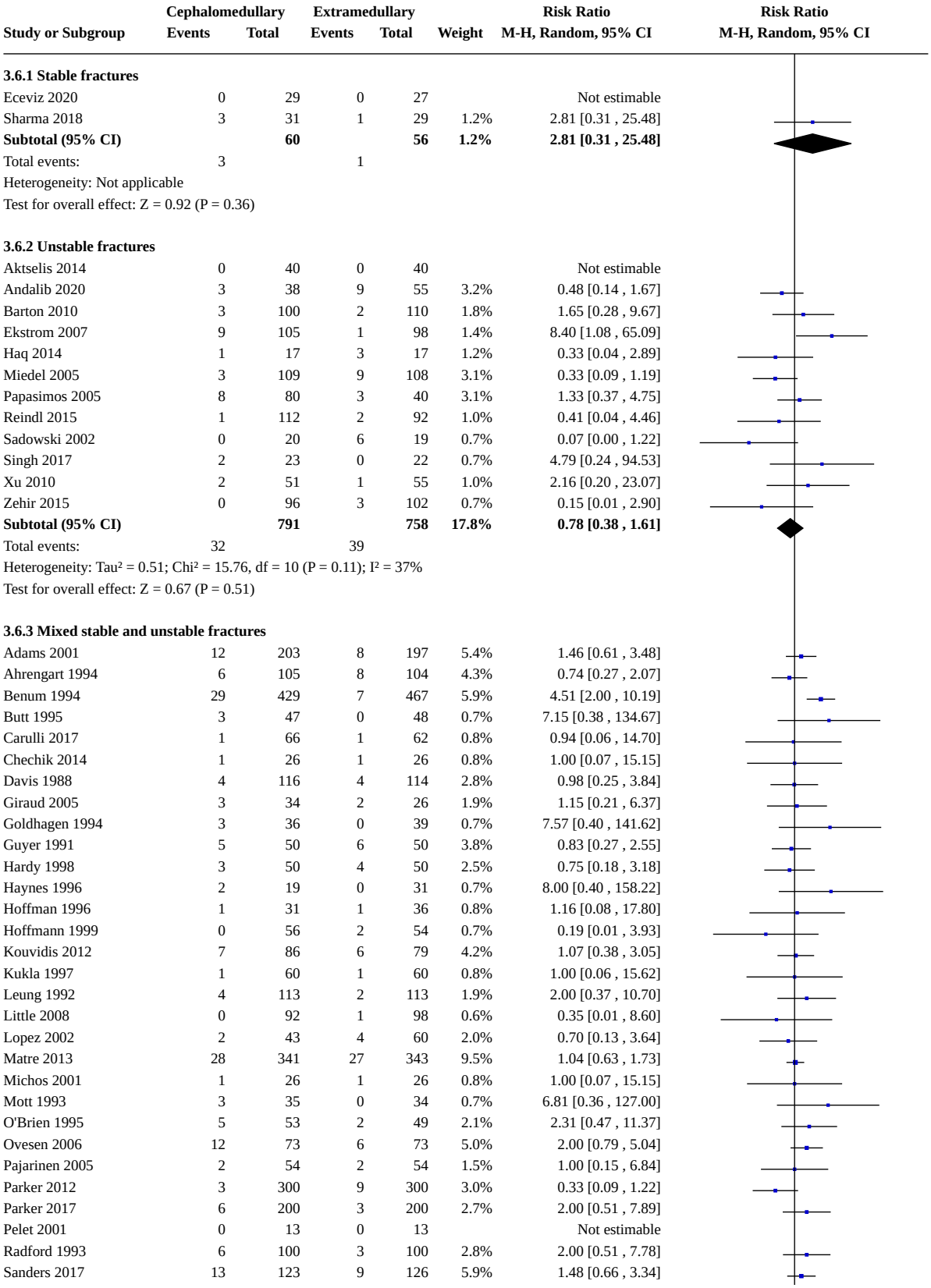


Figure 8. (Continued)

Radford 1993	6	100	3	100	2.8%	2.00 [0.51 , 7.78]
Sanders 2017	13	123	9	126	5.9%	1.48 [0.66 , 3.34]
Saudan 2002	6	100	2	106	2.2%	3.18 [0.66 , 15.39]
Singh 2019	2	30	1	30	1.1%	2.00 [0.19 , 20.90]
Utrilla 2005	1	104	4	106	1.2%	0.25 [0.03 , 2.24]
Zhou 2012	1	36	2	28	1.0%	0.39 [0.04 , 4.07]
Zou 2009	0	58	3	63	0.7%	0.15 [0.01 , 2.94]
Subtotal (95% CI)		**3308**		**3365**	**81.0%**	**1.30 [1.03 , 1.65]**
Total events:	176		132			
Heterogeneity: Tau² = 0.01; Chi² = 33.96, df = 33 (P = 0.42); I² = 3%						
Test for overall effect: Z = 2.17 (P = 0.03)						
Total (95% CI)		**4159**		**4179**	**100.0%**	**1.19 [0.93 , 1.53]**
Total events:	211		172			
Heterogeneity: Tau² = 0.10; Chi² = 53.41, df = 45 (P = 0.18); I² = 16%						
Test for overall effect: Z = 1.36 (P = 0.17)						
Test for subgroup differences: Chi² = 2.24, df = 2 (P = 0.33), I² = 10.6%						

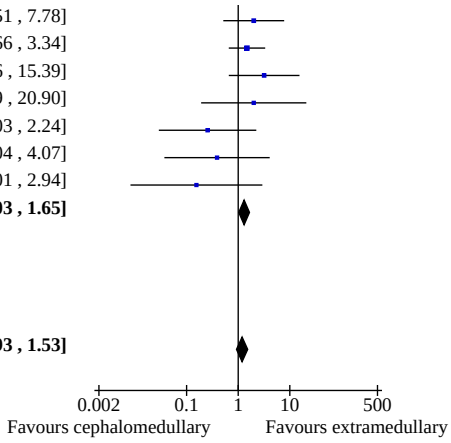


Figure 9. Postoperative periprosthetic fractures: subgrouped according to date of publication

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
4.2.1 Published before 2010						
Bridle 1991	3	34	0	32	3.6%	6.60 [0.35 , 122.96]
Guyer 1991	0	50	0	50		Not estimable
Leung 1992	2	93	0	93	3.4%	5.00 [0.24 , 102.75]
Radford 1993	5	100	0	100	3.8%	11.00 [0.62 , 196.33]
Mott 1993	1	35	0	34	3.1%	2.92 [0.12 , 69.20]
Ahrengart 1994	2	87	0	81	3.4%	4.66 [0.23 , 95.61]
Benum 1994	5	226	0	234	3.7%	11.39 [0.63 , 204.76]
Goldhagen 1994	1	36	0	39	3.1%	3.24 [0.14 , 77.15]
O'Brien 1995	1	53	0	49	3.1%	2.78 [0.12 , 66.62]
Butt 1995	8	47	0	48	3.9%	17.35 [1.03 , 292.39]
Hoffman 1996	1	23	1	31	4.2%	1.35 [0.09 , 20.44]
Kukla 1997	0	45	0	44		Not estimable
Hardy 1998	0	50	0	50		Not estimable
Park 1998	0	30	0	30		Not estimable
Kuwabara 1998	1	20	0	23	3.2%	3.43 [0.15 , 79.74]
Baumgaertner 1998	3	67	0	68	3.6%	7.10 [0.37 , 134.92]
Hoffmann 1999	0	56	0	54		Not estimable
Michos 2001	1	25	0	24	3.1%	2.88 [0.12 , 67.53]
Adams 2001	2	203	1	197	5.4%	1.94 [0.18 , 21.23]
Lopez 2002	0	30	0	38		Not estimable
Harrington 2002	1	50	0	52	3.1%	3.12 [0.13 , 74.78]
Miedel 2005	0	109	0	108		Not estimable
Utrilla 2005	0	82	0	81		Not estimable
Pajarinen 2005	0	54	0	54		Not estimable
Giraud 2005	0	34	0	26		Not estimable
Papasimos 2005	0	80	0	40		Not estimable
Ovesen 2006	2	73	0	73	3.4%	5.00 [0.24 , 102.38]
Ekstrom 2007	0	105	0	98		Not estimable
Little 2008	0	92	0	98		Not estimable
Zou 2009	0	58	0	63		Not estimable
Subtotal (95% CI)		**2047**		**2012**	**57.2%**	**4.43 [2.12 , 9.26]**
Total events:	39		2			
Heterogeneity: Tau² = 0.00; Chi² = 3.59, df = 15 (P = 1.00); I² = 0%						
Test for overall effect: Z = 3.95 (P < 0.0001)						
4.2.2 Published from 2010 onwards						
Barton 2010	0	100	0	110		Not estimable
Xu 2010	1	51	0	55	3.1%	3.23 [0.13 , 77.56]
Hong 2011	0	10	0	10		Not estimable
Kouvidis 2012	1	86	0	79	3.1%	2.76 [0.11 , 66.75]
Zhou 2012	0	36	0	27		Not estimable
Parker 2012	1	300	0	300	3.1%	3.00 [0.12 , 73.35]
Calderon 2013	1	16	0	16	3.2%	3.00 [0.13 , 68.57]
Gou 2013	1	45	0	45	3.1%	3.00 [0.13 , 71.74]
Matre 2013	5	341	1	343	6.8%	5.03 [0.59 , 42.82]
Chechik 2014	0	26	1	26	3.1%	0.33 [0.01 , 7.82]
Aktselis 2014	0	36	0	35		Not estimable
Parker 2017	3	200	0	200	3.6%	7.00 [0.36 , 134.64]
Sanders 2017	7	123	1	126	7.2%	7.17 [0.90 , 57.43]
Xu 2018	0	50	2	50	3.4%	0.20 [0.01 , 4.06]
Sharma 2018	0	31	0	29		Not estimable
Singh 2019	1	30	0	30	3.1%	3.00 [0.13 , 70.83]
Subtotal (95% CI)		**1481**		**1481**	**42.8%**	**2.77 [1.18 , 6.51]**
Total events:	21		5			
Heterogeneity: Tau² = 0.00; Chi² = 6.16, df = 10 (P = 0.80); I² = 0%						
Test for overall effect: Z = 2.34 (P = 0.02)						

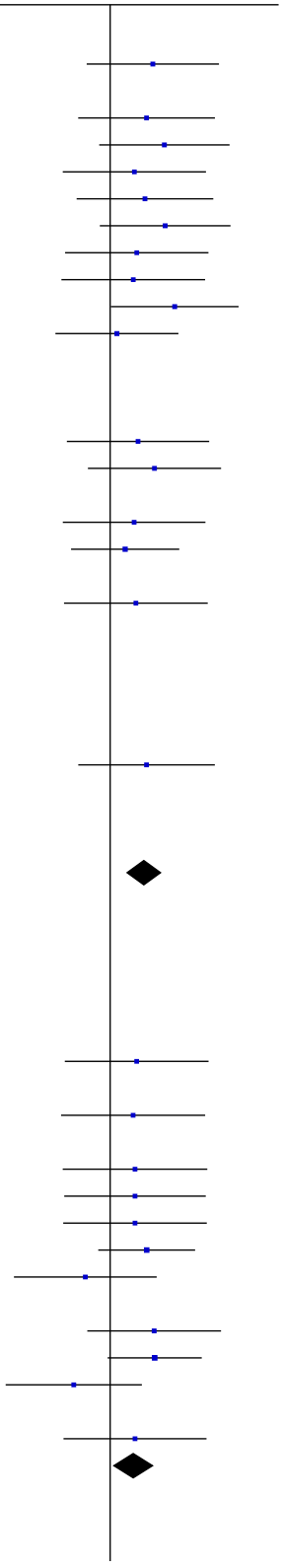
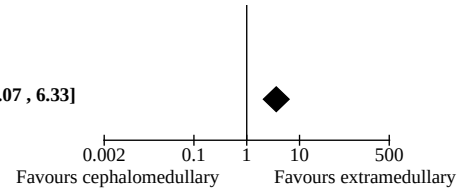


Figure 9. (Continued)

Heterogeneity: Tau² = 0.00; Chi² = 6.16, df = 10 (P = 0.80); I² = 0%
Test for overall effect: Z = 2.34 (P = 0.02)

Total (95% CI)	**3528**	**3493**	**100.0%**	**3.62 [2.07 , 6.33]**	
Total events:	60	7			

Heterogeneity: Tau² = 0.00; Chi² = 10.29, df = 26 (P = 1.00); I² = 0%
Test for overall effect: Z = 4.52 (P < 0.00001)
Test for subgroup differences: Chi² = 0.66, df = 1 (P = 0.42), I² = 0%



Sensitivity analysis

We excluded studies from the primary analyses of our critical outcomes that had high or unclear risks of selection bias for random sequence generation; high risk of attrition bias; high risk of performance bias because surgeons were not equally experienced with both implants; or in which the extramedullary implant had a static design. Overall, these analyses provided no evidence that decisions regarding the approach in the primary analysis influenced the inferences made. See Appendix 8.

DISCUSSION

Summary of main results

We included 76 studies (66 randomised controlled trials (RCTs), 10 quasi-RCTs) with a total of 10,979 participants with 10,988 extracapsular hip fractures. The majority of the studies included trochanteric fractures; 12 of these also included subtrochanteric fractures, one included only basicervical fractures and one included only subtrochanteric fractures. Three studies included only stable fractures, 17 included only unstable fractures and the remaining studies reported a mixed or unknown sample. We also identified two ongoing studies with an estimated recruitment of 388 participants.

We found little evidence to suggest that there was any difference between the interventions across the totality of our critical outcomes; see Summary of findings 1. We collected data at two time points: within four months of surgery; and after four months of surgery, prioritising data at the 12 month time point whenever possible. We found little evidence of a difference between cephalomedullary nails and extramedullary implants in mortality within four months and 12 months of surgery; we judged this evidence to be of moderate certainty. Similarly, we found little evidence indicating any difference in unplanned return to theatre; we judged this evidence to be low-certainty (despite a large sample size, the absolute risk of reoperation was low and the effect estimate was imprecise). The evidence for functional status at four months, and delirium, was derived from few studies and was imprecise including clinically relevant benefits and harms. We judged the certainty of the evidence for mobility at four months to be very low. Studies reported mobility using different measures (such as the number of people with independent mobility and scores on different mobility scales) and the findings from these measures were not consistent. Evidence for independent mobility was presented in most studies reporting this outcome, but these included studies at unclear risks of bias; this potential bias, alongside the inconsistency between different measures, meant that we could not be confident in the findings for early mobility. We were also very uncertain of the findings for performance of activities of daily living (ADL) at four months; we did not pool the data from the four studies because of substantial heterogeneity. Only one small study reported health-related quality of life at four months, from which we were unable to calculate an effect estimate.

For these same outcomes but reported at 12 months, we found little evidence of any difference in the performance of ADL, in measures of health-related quality of life, or functional status. Whilst with some instruments we found little or no difference in mobility, we noted that for one commonly used instrument, the Parker Mobility Scale, there was evidence of a benefit in mobility at 12 months with cephalomedullary nails.

In terms of other important outcomes, we identified no evidence of differences in pain, length of hospital stay or the number of people discharged to their own home or previous residence. For adverse events related to the implant or fracture, we found fewer superficial infections and non-union when a cephalomedullary nail was used, but an increased risk of intraoperative and postoperative implant-related fractures. The absolute risk of these events was low, and the certainty of the evidence was moderate; the difference between event risks equates to a number needed to treat for an additional harmful outcome of 67 for fracture risk, and a number needed to treat for an additional beneficial outcome of 303 for superficial infection risk when using a cephalomedullary nail. In the previous version of this review, it was noted that an evolution in nail design may reduce the implant-related fracture risk; a subgroup analysis exploring this demonstrated no evidence to support such a hypothesis.

We performed further subgroup analyses which showed little evidence of a difference according to whether a short or long cephalomedullary nail was used, or amongst patients with stable or unstable fractures. However, many of the studies included a mix of nail lengths and fracture stabilities, thus limiting the certainty that there was no true difference between subgroups.

Overall completeness and applicability of evidence

The evidence is applicable to older adults with extracapsular fragility hip fractures sustained following low-energy trauma. Where reported, we noted a range of mean ages from 54 to 85 years, and 72% of participants were female. We expected that most studies would include some participants with cognitive impairment; although this was often not reported, only nine studies excluded people with cognitive impairment. Studies did not consistently report American Society of Anesthesiologists (ASA) status scores to indicate participants' fitness for surgery. In general, we assess that the review includes participants that are largely representative of the general hip fracture population.

The included studies were conducted between 1988 and 2020, and more than half were conducted before 2010. Owing to limitations

in the quality of reporting, we could not easily judge whether patient care pathways in these older studies were comparable to current standards of care. It is certainly possible that important developments have been made in cointerventions, such as the introduction of orthogeriatric care in some parts of the world, that have yielded improved outcomes for patients. We are unable to comment about whether such cointerventions may have changed the estimates of the relative benefits and harms between treatments reported here, or the absolute risks following treatment for extracapsular hip fractures.

The studies reported interventions that are generally available for worldwide use; only one study used a cephalomedullary implant described as an experimental design (Dujardin 2001). An evolution in nail design has occurred across the period of time that these studies have been conducted, which raises the possibility that some of the earliest data are no longer applicable to practice. However, our subgroup analysis showed no statistical evidence of a difference between studies published before and after 2010. Overall adverse events were infrequent, and a larger sample would be required to properly evaluate any temporal trends that may reflect improvement in design.

We found that few studies reported outcomes such as ADL or health-related quality of life. These are key components of the core outcome set for hip fracture and yet our ability to draw inferences on the effect of interventions on these outcomes was limited. However, mortality and unplanned return to theatre were generally well-reported, and these outcomes are valued by patients and clinicians in determining the effectiveness of the interventions. We note that this review does not include four studies that were completed in 2011 and 2012 which have not published their findings.

Quality of the evidence

We used GRADE to formally assess the certainty of the evidence for the critical outcomes in this review, with a particular focus on early patient-reported outcome measures (PROMS). We judged several studies to have an unclear risk of selection bias because they did not provide information about randomisation methods; several other studies were deemed to be at high risk of selection bias because they used quasi-randomised methods to allocate participants to groups. We used sensitivity analysis to explore this and found that re-analysing the data without these studies sometimes influenced the direction of the effect, but this rarely changed our inferences. For most outcomes, we downgraded the certainty of the evidence for risk of selection bias. We downgraded the evidence for unplanned return to theatre because all studies for this outcome were at high risk of detection bias.

As with other hip fracture-related Cochrane Reviews (Lewis 2021; Lewis 2022a), PROMS were reported less frequently; approximately two-thirds of the studies predated the publication of the core outcome set which guided the selection of the critical outcomes in this review (Haywood 2014). Where estimates were imprecise, as demonstrated by a wide confidence interval or few study participants, we downgraded for imprecision.

We also downgraded for inconsistency because we were unable to pool data for performance of ADL, owing to substantial statistical heterogeneity. Although we attempted to explore this in the sensitivity analysis, we had insufficient studies to confidently ascertain the reason for this heterogeneity. We did not downgrade the evidence for indirectness as the study populations and types of interventions were consistent with our protocol. We evaluated the risk of publication bias in only six analyses (in which we had more than 10 studies) and found no reason to downgrade the evidence for this potential limitation.

Potential biases in the review process

The review authors conducted a thorough search and independently assessed study eligibility, extracted data, and assessed risk of bias in the included studies before reaching consensus together or with one other review author. This is an update of a previous Cochrane Review from 2010 (Parker 2010), and we have made minor changes to the review in order to meet current methodological expectations in Cochrane intervention reviews (MECIR). The review forms part of a series of Cochrane Reviews of surgery for hip fractures (Lewis 2021; Lewis 2022a; Lewis 2022b; Lewis 2022c). In addition to methodological changes, we made changes to the review in response to guidance resulting from the prioritisation process underpinning this project.

We included only older adults in this review update, in order to better reflect the general population with low-energy fragility hip fractures. This resulted in the exclusion of just one study. We captured outcome data at an additional earlier time point (within four months of surgery); previously, the review included data only at 12 months. There is increasing loss to follow-up over the first year after surgery and some evidence of consistency between quality of life and 'poor outcome' (dead or deterioration in residential status) at four months and 12 months (Griffin 2015). We judged that the earlier time point would provide valuable data. We also restructured the outcomes, bringing them in line with those identified during the prioritisation process and introducing seven critical outcomes consistent with the recommendations from the core outcome set for hip fracture (Haywood 2014). This restructuring resulted in the loss of a small number of outcomes from the review, however the data are still available in Parker 2010. We note that the data for most of the removed outcomes were sparse and typically heterogenous.

The review includes cephalomedullary nails and extramedullary implants from different manufacturers, and there is inevitable variation in the precise detail of their design. We made the assumption that this variation was unlikely to be clinically relevant and chose to group implants from different manufacturers in the analyses. Following consensus discussions with clinicians, we subgrouped the data according to the length of cephalomedullary nails, fracture stability, and (in order to explore newer and older designs of cephalomedullary nals) also by date of reporting; we used sensitivity analysis to remove static designs from the evidence set. These approaches were, however, very limited in explaining variation between the studies because most studies reported using mixed types of implants or only short nails, or included a mixed population of fractures.

We used GRADE only to assess the certainty of the evidence for the critical outcomes in this review that were included in our summary of findings table, as well as for adverse events that indicated a clear improvement or risk with one treatment. We did not report any judgements of certainty for the remaining review outcomes.

Agreements and disagreements with other studies or reviews

The previous version of this review indicated that the sliding hip screw (SHS) appeared to be superior to cephalomedullary nails (Parker 2010); the evidence indicated a lower complication rate for the SHS and an absence of outcome data to support the use of the cephalomedullary nail. Bhandari 2009, which only included studies published up to 2005, also reported findings suggesting that previous concerns about the risk of increased femoral shaft fracture with Gamma nails may have been resolved with improved implant design and improved learning curves with the devices. Another review that specifically focused on the impact of different generations of Gamma nails included studies up to and including 2010, however not all studies were randomised or had a comparator (Noris 2012). The findings of the review by Noris and colleagues also suggested a reduced risk of postoperative fracture but did not address functional and mobility outcomes.

The findings of a more recent review and meta-analysis reported the effectiveness of different implants for trochanteric fractures (Arirachakaran 2017); these included the dynamic hip screw, Medoff sliding plate, percutaneous compression plating, proximal femoral nails, Gamma nails, and Less Invasive Stabilisation System. However, the key outcomes in the work by Ariachakaran and colleagues were operative time, blood loss and hospital stay, which differ from our critical outcomes.

Other reviews in this area focused on specific types of implants such as short or long nails (Bovbjerg 2019), single or double screws (Cipollaro 2019), whether to use distal locking (Li 2020), or whether reaming was necessary (Clark 2021). Although we explored the length of cephalomedullary nails in subgroup analysis, our analyses included few studies of only long nails and we could not confidently report differences between the two lengths.

Our review included two large multicentre studies (of over 500 participants) published within the last ten years, the findings of which are consistent with our review (Matre 2013; Parker 2012). A further large, multicentre study is due to be published soon (NCT01380444); this may influence the results of our review and will be included in future updates.

AUTHORS' CONCLUSIONS

Implications for practice

Extramedullary devices, most commonly the sliding hip screw, yield very similar functional outcomes to cephalomedullary devices in the management of extracapsular fragility hip fractures. There is, however, a difference in the adverse event profile associated with these types of devices; there is a reduced risk of infection and non-union with cephalomedullary nails, however there is also an increased risk of implant-related fracture that is not attenuated with newer designs. Overall, using a cephalomedullary nail in the treatment of these fractures in preference to an extramedullary device saves one infection per 303 patients and causes one additional implant-related fracture per 67 patients. There is insufficient evidence to determine whether cephalomedullary devices yield better outcomes in more unstable fracture patterns or whether long or short nail designs are preferable.

Implications for research

In common with the findings of our other reviews in this field (Lewis 2021; Lewis 2022a), very considerable research resources have been and are being committed to this field; we identified two ongoing studies that may contribute data in future review updates. It is unlikely that future research will importantly alter our inferences about the relative clinical effectiveness of extramedullary and cephalomedullary implants. The estimates of any difference between these interventions for some critical outcomes are imprecise; however, the totality of the available data provide little evidence to suggest that any effect is likely to be clinically meaningful. This is consistent with the findings of the more recent, larger and better reported studies in this review (Matre 2013; Parker 2017).

Commonly expressed opinions advocating the use of the more expensive cephalomedullary interventions include benefits in the treatment of unstable fracture patterns and a considerable reduction in complications with newer designs. This review demonstrates that convincing evidence for these beliefs is not available. We recommend that researchers focus on the unstable fracture subpopulation in future studies; it is likely that any clinically relevant benefit that warrants the additional implant-related fracture risk associated with nails is likely to be most evident here.

We encourage investigators to address the limitations in the quality of the evidence in the field through better study design and clear reporting about methods of randomisation and allocation concealment, as well as attempting to minimise attrition for participant-reported outcomes. We raise the awareness amongst investigators of the core outcome set for hip fracture that should be included in every RCT in hip fracture (Haywood 2014). To date, few studies have considered patient-relevant outcomes such as performance of activities of daily living, health-related quality of life, mobility or delirium.

Given the recommendations in Haywood 2014, we recommend that future studies are large enough to detect differences in health-related quality of life. Having reviewed the included studies we estimate that the standard deviation for EQ-5D at four months post-diagnosis is approximately 0.3. Assuming a minimum clinically important difference of 0.07 (Walters 2005), and an observed attrition in the included studies approaching 40%, we recommend future samples of no less than 1000 participants in order to ensure that estimates are sufficiently precise.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Adams 2001

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma nail versus SHS
Participants	**Total number of randomised participants:** 400 **Inclusion criteria:** diagnosis of intertrochanteric fractured femur **Exclusion criteria:** inability to give informed consent, too frail for any operative intervention, and residence outside the region of the hospital because of the difficulty of follow-up **Setting:** single centre; orthopaedic hospital, UK **Intervention group 1** (Gamma nail) • Age (mean (range)): 81.2 (48 to 99) years • Gender (male(M)/female(F)): 39/164 • Mobility assessment (independent/1 stick/2 sticks/walking frame/wheelchair and transfer): number (n) = 88/53/2/32/28 • Place of residence (own home/part IV or relative or home for elderly/acute hospital/nursing home or long stay): n = 104/27/5/67 • Preoperative waiting time: mean 1.7 days; range 1.5 to 1.9 days

Adams 2001 *(Continued)*

- Fracture classification (AO/OTA A1.1/A1.2/A1.3/A2.1/A2.2/A2.3/A3.1/A3.2/A3.3/B2.1): n = 41/38/0/27/40/33/2/2/2/18

Intervention group 2 (DHS)

- Age (mean (range)): 80.7 (32 to 102) years
- Gender (M/F): 49/148
- Mobility assessment (independent/1 stick/2 sticks/walking frame/wheelchair and transfer): n = 88/48/6/29/26
- Place of residence (own home/part IV or relative or home for elderly/acute hospital/nursing home or long stay): n = 115/27/12/43
- Preoperative waiting time: mean: 1.8 days; range 1.6 to 2.1 days
- Fracture classification (AO/OTA A1.1/A1.2/A1.3/A2.1/A2.2/A2.3/A3.1/A3.2/A3.3/B2.1): n = 43/29/1/22/50/27/1/4/5/15

Note: study authors do not report baseline characteristics for: smoking history, medications, BMI, co-morbidities, cognitive status/dementia or ASA status

Interventions

General details: study authors report that surgeons were experienced with both implants; both groups received standard 3-dose IV cefuroxime and routine antithrombotic prophylaxis; clinical follow-up for 1 year or until death (3 months, 6 months, 12 months)

Intervention group 1

- Gamma intramedullary nail (Stryker-Howmedica Ltd, London, UK); short type. Study authors did not report if the lag screw was static or locked; the most common implant was the 130-degree by 11 mm nail; distal locking screws were used at the preference of the surgeon.
- Number randomised = 203; losses = unknown (study authors report one loss but do not report from which study group, so we have used all participants in analysis for both groups); analysed for mortality = 203 at 12 months; analysed for reoperation = 203 at 12 months; analysed for implant failure = 203 at 12 months; analysed for DVT = 203 at 12 months; analysed for superficial infection = 203; analysed for deep infection = 203; HHS = 156 at 3 months, and 126 at 12 months

Intervention group 2

- CHS (Smith & Nephew, UK). The most common implant was the 135-degree, 3-hole plate.
- Number randomised = 197; losses = unknown (study authors report one loss but do not report from which study group, so we have used all participants in analysis for both groups), analysed for mortality = 197 at 12 months; analysed for re-operation = 197 at 12 months, analysed for implant failure = 197 at 12 months; analysed for DVT = 197 at 12 months; analysed for superficial infection = 197; analysed for deep infection = 197, HHS = 152 at 3 months, and 121 at 12 months

Note: study authors did not specify time to mobilisation

Outcomes

Outcomes measured/reported by study authors: length of surgery; operative blood loss; postoperative haemoglobin; tip-apex distance; number of patients transfused; operative fracture of the femur; later fracture of the femur; cut-out of implant; detachment of the plate from the femur; reoperation; deep wound infection; superficial wound infection; DVT; mortality; use of walking aids; place of residence at follow up; HHS (available at 3, 6, 12 months)

Outcomes relevant to the review: functional status (HHS; at 3 and 12 months); mortality (12 months); unplanned return to theatre (12 months); mobility (walking independently or with one stick at 12 months); complications: superficial infection; deep infection; intra-operative and postoperative fracture; blood transfusion; fixation failure; MI; DVT; cut-out; femoral fracture (all at 12 months)

Note: HHS was reported without SD; we included these data in an appendix because we could not include them in analysis.

Notes

Funding/sponsor/declarations of interest: quote: "Although none of the authors has received or will receive benefits for personal or professional use from a commercial party related directly or indirectly to the subject of this article, benefits have been or will be received but are directed solely to a research

Adams 2001 *(Continued)*

fund, the Scottish Orthopaedic Research Trust into Trauma, a non-profit organisation with which one or more of the authors is associated."

Study dates: February 1994 to June 1995

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomised by closed envelopes, no further details
Allocation concealment (selection bias)	Low risk	Quotes: "At admission, patients were randomized by a closed, opaque envelope method and were assigned to receive either..." Confirmed by Adams in 2001 that "the opaque envelopes were sequentially numbered", and that there was concealment of allocation
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeon performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote (from draft report): "The surgeons were experienced in the insertion of both implants"
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	Quote: "Observed-blinded functional assessments were carried out by the unit research physiotherapist, by use of the Harris hip score."
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses were explained by death, which is expected in this population, and losses were reasonably balanced between groups.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report details of pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Adeel 2020

Study characteristics

Methods	RCT; parallel design

Adeel 2020 *(Continued)*

	Review comparison group: PFN versus DHS
Participants	**Total number of randomised participants:** 68 **Inclusion criteria:** 40 to 75 years of age; presenting with AO type A2 and A3 pertrochanteric fracture of femur diagnosed on history; clinical examination and radiograph **Exclusion criteria:** people with anaesthesia risk; pathological fracture; previous surgical intervention on the affected hip; metabolic bone disease diagnosed on history, clinical examination, baseline investigations, ECG, and radiograph **Setting:** single centre; hospital; Pakistan **Baseline characteristics** **Intervention group 1** (PFN) • Age (mean (SD)): 59.32 (± 2.39) years • Gender (M/F): 25/9 • Fracture classification (A2/A3): n = 17/19 (we noted a discrepancy - reported numbers do not add up to 34) **Intervention group 2** (DHS) • Age (mean (SD)): 60.88 (± 12.49) years • Gender (M/F) = 22/12 • Fracture classification (A2/A3): n = 15/17 (we noted a discrepancy - reported numbers do not add up to 34) **Note:** study authors do not report baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, ASA status or preoperative waiting times
Interventions	**General details:** single surgical team; cetriaxone 1 g given half an hour before surgery, and continued 2 g per day for 3 postoperative days; general or spinal anaesthesia; encouraged to take up ankle and calf exercises from POD 1, mobilised non-weight-bearing from POD 2 depending on physical condition of patient **Intervention group 1** • PFN; study authors did not report the nail manufacturer, type of lag screw, whether the lag screw was locked or dynamic or the length of the nails • Number randomised to group = 34; losses = none; analysed for all outcomes = 34 **Intervention group 2** • CHS; study authors did not report the manufacturer of the extramedullary device • Number randomised to group = 34; losses = none; analysed for all outcomes = 34 **Note:** study authors do not report the skills or experience of surgical team
Outcomes	**Outcomes measured/reported by study authors:** union, operation time, volume of blood loss, complications (infection, non-union, malunion, and implant failure); functional outcome (using HHS with grades of excellent, good, fair, and poor; and mean scores) **Outcomes relevant to the review:** functional status (mean HHS; at 12 months); complications: superficial infection; implant failure; non-union (all at 12 months)
Notes	**Funding/sponsor/declarations of interest:** no funding; study authors declare no conflicts of interest **Study dates:** September 2015 to September 2017

Adeel 2020 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Random number generation but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The skills and experience of surgical team is not reported and it is unknown if surgeon experience was comparable for both types of implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias

Ahrengart 1994

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** intramedullary nail versus SHS
Participants	**Total number of randomised participants:** 492 **Inclusion criteria:** intertrochanteric (stable and unstable) **Exclusion criteria:** subtrochanteric and pathologic fractures, earlier fractures or operations on the same hip, or if the surgeon was unfamiliar with the Gamma nail technique **Setting:** multicentre; 5 hospitals; Sweden and Finland

Ahrengart 1994 *(Continued)*

Baseline characteristics (only reported for the 426 patients that completed the study (according to linked study report Ahrengart 2002))

Intervention group 1 (Gamma nail) (n = 210)

- Age (median (range)): females: 82 (48 to 96), males: 77 (44 to 90)
- Gender (M/F): 61/149
- Need for walking aid/wheelchair dependent/bedridden: n = 78/15/3
- Place of residence (live at home): 72%
- ASA status (I/II/III/IV): 16%/42%/34%/8%
- Fracture classification (Evans as modified by Jensen and Michaelsen; I/II/III/IV/V): 16%/35%/15%/16%/18%

Intervention group 2 (SHS) n = 216

- Age (median ((range)): females 81 (54 to 99) years, males 74 (32 to 98) years
- Gender, M/F: 60/156
- Need for walking aid/ wheelchair dependent/ bedridden: 78/13/7
- Place of residence, live at home: 66%
- ASA status (I/II/III/IV): 20%/39%/36%/6%
- Fracture classification (Evans as modified by Jensen and Michaelsen; I/II/III/IV/V): 18%/35%/18%/19%/10%

Notes

- Study authors do not report baseline characteristics for: smoking history, medications, BMI, comorbidities, cognitive status/dementia
- 85% were operated on the day of admittance or the following day; 96% were treated within 2 days

Interventions

General details: operations were carried out by surgeons of varying grades from junior resident to staff surgeons, and surgeons were excluded from the trial if not adequately experienced with the Gamma nail; 90% received spinal anaesthesia and 81% received antibiotic prophylaxis, 75% received anticoagulants, 56% received dextran and 18% received heparin or warfarin; compression stockings or other physical preventive measures occasionally used; open reduction in some cases; full weight-bearing immediately in 88% of cases

Intervention group 1

- Gamma intramedullary nail; short nails were used for all patients; 12 mm nail used in 73% of patients; 14 mm nail used in 20% of patients; 16-mm nail used in 7%; distal locking in 68% of patients with stable fractures and 74% of patients with unstable fractures
- Randomised = unknown; losses unknown; analysed for mortality = 210; analysed for unplanned return to theatre, intraoperative fracture, cut out, deep infection, non-union, DVT = 105 ; analysed for pain = 88; analysed for postoperative fracture = 87

Intervention group 2

- Sliding hip screw (either Richard's Classic, Smith & Nephew or Dynamic Hip Screw, Synthes); two-hole plates were used in 5%, four-hole plates were used in 67%, five-hole plates were used in 20%, six-hole plates were used in 7%, and eight- or 10-hole plates were used in 2%
- Randomised = unknown; losses unknown; analysed for mortality = 216; analysed for unplanned return to theatre, intraoperative fracture, cut out, deep infection, non-union, DVT = 104; analysed for pain = 83; analysed for postoperative fracture = 81

Notes

- Study authors did not report: type of anaesthesia, pre-and postoperative use of prophylactic antibiotics and anti thromboembolics, time to mobilisation or weight-bearing

Ahrengart 1994 *(Continued)*

- 66 participants were lost to follow-up because of advanced age, other physical illness, or dementia. These participants were excluded from analysis. It is not clear how many were initially randomised to each group, and to which group these lost participants belonged.

Outcomes	**Outcomes measured/reported by study authors:** LOS, residence at 6 months, lag screw position, length of skin incisions, operative time, blood loss, transfusion, superficial wound infection, deep wound infection, operative fracture of femur, fracture reduction, screw cut-out, mortality, femoral medialisation (sliding of lag screw), lateral pain over the femoral head screw, pain at the top of the greater trochanter, thromboembolic complication (DVT, PE); clinical complications (pneumonia); shortening of leg; return to pre-fracture residential status; use of walking aids; length of skin incision; all 6 months **Outcomes relevant to the review:** mortality (6 months); mobility (6 months); unplanned return to theatre (reported as revision, 6 months); pain (reported as lateral pain over the femoral head screw and pain at the top of the greater trochanter, assumed to be at 6 months); complications: cut-out; deep infection; intraoperative and postoperative fracture; venous thromboembolic phenomena (DVT and PE reported) (all at 6 months) **Notes** • We did not include pneumonia, infection, PE, intra- and postoperative fractures in the analysis because data were not provided for each intervention group. • For mobility, we used data from the Ahrengart 2002 paper which reported data for needing walking aids. We reversed these data in order to include it in the review outcome 'independent mobility'.
Notes	**Funding/sponsor/declarations of interest:** supported by grants from The Karolinska Institute Foundation, Lund University, Skane County Council and Stryker-Howmedica **Study dates:** not reported **Note:** there are multiple publications for this study. The 2002 paper by Ahrengart and colleagues has data from all 5 centres, but has less detail than some earlier reports. Given the absence of information on 66 patients lost to follow-up in this report — and some lack of clarity or potential inconsistencies with the 2-centre study regarding surgical experience, trial inclusion criteria, outcome definitions and some results — we have mostly used data from the Fornander 1994. We have reported the baseline data from Ahrengart 2002 as well as outcome data for mortality and mobility.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomised by consecutively opened sealed envelopes; no additional details
Allocation concealment (selection bias)	Low risk	Quote: "Randomization was achieved using sealed envelopes in numerical order before the patient was taken to the operating room."
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Surgery was done by various orthopaedic surgeons, from junior residents to staff surgeons, and surgeons were excluded from trial participation if unfamiliar with the Gamma nail technique.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.

Ahrengart 1994 *(Continued)*

Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	We could not adequately assess risk of attrition bias because findings were reported by different trial centres at different points in time, and we noted variation in numbers of lost participants which were not sufficiently explained.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Akhtar 2016

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: PFNA versus DCS
Participants	**Total number of randomised participants:** 60 **Inclusion criteria:** people with unstable proximal femur fracture of 31A2 and 31A3 within 7 days of fracture; 40 to 70 years of age; either gender **Exclusion criteria:** people with 31A1 type fracture, pathological fractures, presence of neurovascular injury, inability to walk before injury, significant medical comorbidity like diabetes mellitus, CLD, CRF, chronic steroid use; not fit for anaesthesia **Setting:** hospital; single centre; Pakistan **Baseline characteristics** **Intervention group 1** (PFNA) • Age (mean (SD)): 55.4 (± 7.89) years • Gender (M/F): 17/13 • Fracture classification (31A2/31A3): n = 21 (70%)/9 (30%) **Intervention group 2** (DCS) • Age (mean (SD)): 55.53 (± 7.7) years • Gender (M/F): 18/12 • Fracture classification (31A2/31A3): n = 22 (73.33%)/8 (26.67%) **Note:** study authors did not report baseline characteristics for smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, ASA status or preoperative waiting times
Interventions	**General details:** study authors reported no treatment details

Akhtar 2016 *(Continued)*

	Intervention group 1 • PFNA; study authors do not report the length or diameter of cephalomedullary nails used • Number randomised = 30 **Intervention group 2** • DCS • Number randomised = 30
Outcomes	**Outcomes measured/reported by study authors:** union time **Outcomes relevant to the review:** none
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** September 2015 to March 2016 **Note:** study authors do not report outcomes relevant to the review. We have, therefore, not conducted risk of bias assessments.

Aktselis 2014

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** short intramedullary Gamma nail versus SHS (AMBI)
Participants	**Total number of randomised participants:** 80 **Inclusion criteria:** an unstable 31.A2.2 or 31.A2.3 (but not 31.A2.1) fracture type according to the AO/OTA classification, greater than 65 years old **Exclusion criteria:** bilateral fractures, pathologic fractures, previous chemotherapy and/or radiotherapy, rheumatic diseases, polytrauma, a previous operation in the same hip/femur and an ASA score of IV or V **Setting:** single centre; hospital; Greece **Baseline characteristics** (only for analysed participants) **Intervention group 1** (Gamma nail) • Age (mean (SD)): 82.9 (± 5.8) years • Gender (M/F): 8/28 • ASA status (I/II/III/IV): 2/20/14/0 **Intervention group 2** (SHS) • Age (mean (SD)): 83.1 (± 6.5) years • Gender (M/F): 7/28 • ASA status (I/II/III/IV): 2/27/6/0 **Note:** study authors did not report smoking history; medication; BMI; preoperative waiting time; co-morbidities; mobility; or place of residence
Interventions	**General details:** fracture table; spinal anaesthesia; single-dose antibiotics preoperatively continued 48 hours; no suction drain; mobilisation with a walker and weight-bearing as tolerated and assessment of

Aktselis 2014 *(Continued)*

	post-operative X-rays; all operations supervised by consultant orthopaedic surgeons familiar with both procedures; clinical follow-up at 1, 3, 6, and 12 months **Intervention group 1** • Short intramedullary Gamma nail (Stryker, Schönkirchen, Germany); 125-degree nail (except for 3 cases with 130-degree); study authors did not comment on whether the lag screw was static or dynamic or on the configuration of distal locking • Randomised = 40; losses = 4 (death); analysed at 12 months = 36 **Intervention group 2** • SHS (AMBI, Smith & Nephew, Memphis, USA); 3- or 4-hole plates • Randomised = 40; losses = 5 (death); analysed at 12 months = 35 **Note:** study authors did not report details of preoperative procedure
Outcomes	**Outcomes measured/reported by study authors:** mobility (available at 1, 3, 6, and 12 months); daily function - Barthel Index (available at 1, 3, 6, and 12 months); EQ-5D - HRQoL (available at 1, 3, 6, and 12 months); mortality; duration of surgery; radiation time; LOS; hip pain; mechanical failure; cut-out; non-union; fracture (intraoperative and late); fixation failure; infection; reoperation **Outcomes relevant to the review:** ADL (Barthel Index, 3 and 12 months); HRQoL (EQ-5D, 3 & 12 months); mobility (Parker 1993, 3 & 12 months); unplanned return to theatre (described as cut-outs necessitating reoperation; 12 months); LOS; pain (reported as number with hip pain; 3 and 12 months); mortality (12 months); complications: intra- and postoperative fractures; cut-outs; plate/screw failure (reported as fixation failure); deep infection (all at 12 months) **Note:** study authors reported data for ADL, HRQoL and mobility at 3 months without denominators, and we did not include these data in meta-analysis; we included these data in an appendix
Notes	**Funding/sponsor/declarations of interest:** funding not reported. The study authors declare no conflicts of interest. **Study dates:** October 2008 until January 2011

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Envelopes were picked from a box, however method of sequence generation is not described
Allocation concealment (selection bias)	Low risk	Quote: "Sealed, opaque envelopes picked from a box in the presence of 3 surgeons"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Operations supervised by 4 consultant surgeons with experience in both techniques
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.

Aktselis 2014 *(Continued)*

Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few losses which were balanced between groups and explained by death, which is expected in this population
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Andalib 2020

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: cephalomedullary nail versus DHS and DCS

Participants	**Total number of randomised participants:** 113
	
	Inclusion criteria: unstable intertrochanteric fractures, candidate for extramedullary or intramedullary surgery, ability to walk without any assistance before the fracture, signed informed consent
	
	Exclusion criteria: uncontrolled diabetes mellitis, using immunosuppressive drugs, any kind of malignancies as well as those who refused to continue the trial
	
	Setting: multi-centre; 2 trauma centres; Iran
	
	Baseline characteristics (data only for those that were not lost to follow-up/excluded)
	
	Intervention group 1 (intramedullary)
	
	• Age (mean (SD)): 64.4 (± 15.5) years
	• Gender (M/F): 17/21
	• BMI (mean (SD)): 25.17 (± 4.7) kg/m^2
	• Additional information:
	  ◦ LEM (mean (SD)): 71.24 (± 9.3)
	
	Intervention group 2 (extramedullary)
	
	• Age (mean (SD)): 61.45 (± 17.0) years
	• Gender (M/F): 26/29
	• BMI (mean (SD)): 25.03 (± 3.9) kg/m^2
	• Additional information:
	  ◦ LEM (mean (SD)): 70.65 (± 9.8)

Andalib 2020 *(Continued)*

	Note: study authors reported no baseline data for: smoking history, medication, comorbidities, place of residence, cognitive status, ASA status, fracture classification or preoperative waiting times
Interventions	**General details:** no details **Intervention group 1** • Cephalomedullary nail (supplied by Osveh Asia Medical Instrument Company, Mashhad, Iran). Study authors did not report the manufacturer, length of the nail, details about the lag screw or the configuration of distal locking. • Number randomised to group = 43; losses = 5 (3 died; 2 unable/unwilling to continue); analysed at 12 months = 38 **Intervention group 2** • Mix of DHS and DCS (supplied by Osveh Asia Medical Instrument Company, Mashhad, Iran) • Randomised = 70 (51 DHS, 19 DCS); losses = 15 (6 died and 5 unable/unwilling to continue in DHS; 2 died and 2 unable/unwilling to continue in DCS); analysed = 55 (40 DHS; 15 DCS) **Notes** • Study authors do not explain why 2 different types of extramedullary implant are used, and we note that these devices are not equally balanced between participants in this group • Study authors report no surgical management information for: number of clinicians (and their skills and experience), type of anaesthesia, pre- and postoperative care (e.g. use of prophylactic antibiotics or antithromboembolics) or rehabilitation (e.g. time to mobilisation or weight-bearing)
Outcomes	**Outcomes measured/reported by study authors:** ADL (using LEM score; measured at baseline and 1, 3, 6, and 12 months after surgery); device failure (cut-out, migration of screw, breakage of implant); need for reoperation; fracture union; limb shortening; return to previous level of activity (before fracture); superficial and deep infections; mortality **Outcomes relevant to the review:** ADL (using LEM; higher scores indicate better function in ADL; at 3 months and 12 months); mortality (12 months), unplanned return to theatre (reported as reoperation; at 12 months); complications: superficial and deep infection; non-union; plate/screw failure (reported as device failure) (all at 12 months)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** March 2016 to June 2018

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization into the groups was performed using stratification and blocking methods"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	We did not expect lack of blinding of surgeons to influence performance and outcome data for this review.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in the study.

Andalib 2020 *(Continued)*

Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses were explained by death, which is expected in this population. Other losses (due to being unable or unwilling to continue in the study) were few and were reasonably balanced between study groups.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Barton 2010

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** long Gamma intramedullary nail versus SHS
Participants	**Total number of randomised participants:** 210 **Inclusion criteria:** > 18 years of age; AO/OTA 31-A2 fracture of the proximal part of the femur **Exclusion criteria:** pathological fractures; previous proximal femoral fractures; reverse oblique fractures (AO/OTA 31-A3), decision by surgeon not to include patient in the study **Setting:** single centre; orthopaedic hospital; UK **Baseline characteristics** **Intervention group 1** (Gamma nail) • Age (mean (range)): 83.1 (42 to 99) years • Gender (M/F): 19/81 • Cognitive status (Mini-mental score; 10 points/ < 10 points): n = 45/55 • ASA status (I/II/III/IV): 0/47/49/4 **Intervention group 2** (SHS) • Age (mean (range)): 83.3 (56 to 97) years • Gender (M/F): 25/85 • Cognitive status (Mini-mental score; 10 points/ < 10 points): n = 67/43 • ASA status (I/II/III/IV): 2/46/59/3 **Overall**

Barton 2010 *(Continued)*

- Age (mean (range)): 83.2 (42 to 99) years
- Gender (M/F): 166/44
- Cognitive status (Mini-mental score; 10 points/ < 10 points): n = 112/98
- ASA status (I/II/III/IV): 2/93/108/7

Notes

- Study authors did not report smoking history; medication; BMI; preoperative waiting time; comorbidities; mobility or place of residence
- Study authors reported no significant difference with baseline characteristics (except for mini mental test score)

Interventions	**General details:** traction table; aspirin and thromboembolism-deterrent stockings for thromboprophylaxis; mobilisation with weight-bearing; clinical follow-up at 3, 6 and 12 months; 32 consultant orthopaedic surgeons all had experience with both techniques **Intervention group 1** • Long Gamma intramedullary nail; 130 degree nail; distal locking with 2 screws • Randomised = 100; 2 died prior to surgery; 65 followed up at 12 months (losses due to 32 deaths and 3 reoperations) **Intervention group 2** • SHS; 4 hole; 135 degree plate • Randomised = 110; 86 followed up at 12 months (losses due to 24 deaths and 2 reoperations)
Outcomes	**Outcomes measured/reported by study authors:** number of participants transfused; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union; deep wound infection; reoperation; LOS; mortality; change in mobility score (measured on a 5-point ordinal scale); change in residential status (measured on a 5-point ordinal scale); quality adjusted life years (EQ-5D scores); length of follow-up: 12 months **Outcomes relevant to the review:** mobility (change in mobility score, 12 months); mortality (1 and 12 months); unplanned return to theatre (12 months); LOS; complications (12 months): intra- and postoperative fractures; cut-out; plate/screw failure (reported as implant failure); deep infection, blood transfusion (all at 12 months) **Note:** study authors collected data for HRQoL (EQ-5D) but did not report these data
Notes	**Funding/sponsor/declarations of interest:** no external funding **Study dates:** April 2003 to April 2006 (from trial registration documents) **Notes** • Significance testing was corrected for a significantly higher proportion of patients with a lower mini-mental score in the nail group. • Information on methods and extra data received from lead study author (5 May 2010)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Sequence generation was prepared by a medical statistician and we assumed that this was done adequately and independently.
Allocation concealment (selection bias)	Unclear risk	Quote: "Randomization was carried out with use of sealed envelopes generated by a medical statistician. Once a patient was considered to be appropriate for inclusion, consent was obtained. An envelope was then selected and opened at a daily trauma meeting."

Barton 2010 *(Continued)*

		Comment: study authors do not report if envelopes were opaque or sequentially-numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeon performance.
Other performance bias: surgeon experience of both implants	Low risk	All 32 surgeons were experienced with both implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses were explained by death, which is expected in this population, and were reasonably balanced between groups.
Selective reporting (reporting bias)	Unclear risk	Retrospective trial registration document (ISRCTN79362886; received in March 2009). It is not feasible to use these retrospective documents to effectively assess risk of selective reporting bias.
Other bias	Low risk	We identified no other sources of bias.

Baumgaertner 1998

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IMHS versus SHS
Participants	**Total number of randomised participants:** 131; 135 trochanteric femoral fractures (4 of these were fractures which occurred several months later in the same patients) **Inclusion criteria:** intertrochanteric fracture **Exclusion criteria:** pathological fractures **Setting:** 2 orthopaedic hospitals; USA **Baseline characteristics (overall)** • Age (mean (range)): 79 (40 to 99) years • Gender (M/F): 45/86

Baumgaertner 1998 *(Continued)*

Baseline characteristics

Intervention group 1 (hip screw)

- Mobility assessment
  - Barthel Index > 90: 54%
  - Community ambulators: 54%
- Fracture classification (stable/unstable): n = 30/37

Intervention group 2 (SHS)

- Mobility assessment
  - Barthel Index > 90: 74%
  - Community ambulators: 70%
- Fracture classification (stable/unstable): n = 35/33

Note: study authors did not report smoking history; medication; BMI; preoperative waiting time; co-morbidities; mobility or place of residence

Interventions	**General details:** antibiotic and DVT prophylactic; weight-bearing according to individual patient characteristics (17 allowed weight-bearing as tolerated, 107 restricted to partial weight-bearing); surgical experience: Gamma nail: familiar with intramedullary nailing but not the Gamma nail; SHS routine; surgery by residents under supervision, 30 participating surgeons (all had been using SHS, but had not used the IMHS); clinical follow-up at 6 weeks and 3, 6, 12 and 24 months **Intervention group 1** • IMHS (Smith & Nephew), nail length 21 cm; diameter 12 mm to 16 mm; 37 of the 67 screws were distally locked • Randomised = 67; 52 analysed after drop out due to death and further surgery **Intervention group 2** • SHS; 3- to 8-hole plates • Randomised = 68; 53 analysed after drop out due to death and further surgery **Note:** 12 died within 3 months; 2 had additional orthopaedic surgery; 7 had hardware failure. Overall, 105 patients were analysed for clinical outcomes.
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; transfusion; radiographic screening time; operative fracture of the femur; later fracture of the femur; cut-out of implant; wound haematoma; major medical complication; LOS; hospital charges; mortality; hip pain at follow-up; return to pre-fracture residence; patient mobility; length of follow-up: mean 28 months (range 4 to 54 months) **Outcomes relevant to the review:** mortality (12 months); pain (experiencing pain, 12 months); mobility (failure to regain pre-fracture mobility); LOS; discharge destination (to own home); complications: cut-out; intra and postoperative fracture (all at 12 months)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** March 1992 to March 1994 **Notes** • We noted some confusion in the study report related to participant and fracture numbers. Study authors explain that 4 participants had 2 fractures which were operated on several months apart (they were not bilateral fractures). These were considered separate operations and different cases for pre-operative and operative data. Two of the 4 patients received both the IMHS and SHS, and were excluded from longer term follow-up data but not mortality (where they were only counted once in the analysis).

Baumgaertner 1998 *(Continued)*

- We included some information on methods and data from communication with the study author on 1 November 1998.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Use of sealed envelopes, but method of sequence generation is not reported
Allocation concealment (selection bias)	Low risk	Quote: "two hundred sealed opaque envelopes were randomly (cards were shuffled) assigned to either the IMHS or CHS, and numbered in sequential order, after enrolment in the study the next envelope was opened to reveal the device selected for the patient, no one was aware of the next upcoming device."
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	All participating attending surgeons had been using SHS before the start of the study and, although they were familiar with nailing, they previously had not used the IMHS.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were balanced between groups and were mostly explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or reference for a prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Benum 1994

Study characteristics

Methods	RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus CHS

Benum 1994 *(Continued)*

	Note: this study included multiple interim reports and abstracts. For the overall number of randomised participants, we used the publication that had the highest number of participants because we expected that this was a summary of the completed study. We also used this report for the number of randomised participants per group and for unplanned return to theatre data. However, this report was an abstract with very limited detail. For adverse event data, we used data from an earlier abstract with 460 participants.
Participants	**Total number of randomised participants:** 912 **Inclusion criteria:** trochanteric and subtrochanteric proximal femoral fractures. One study publication referred to the Jensen and Zickel classifications and tabulated stable, unstable and subtrochanteric fractures (Aune 1994). **Exclusion criteria:** not reported **Setting:** orthopaedic hospitals, Norway **Baseline characteristics (overall)** • Age (mean (range)): not stated (of 378: mean 81 years; range 45 to 96 in Aune 1994) • Gender (M/F): not stated (41% in Aune 1994) **Note:** we have only reported baseline data as described in the previous version of this review. The abstract for 912 participants did not report baseline data.
Interventions	**General details:** surgical experience is unknown for all centres but for subgroup in 1 centre (Aune 1994) **Intervention group 1** • Gamma intramedullary nail (Howmedica). Short nails were used in all cases; study authors did not report if the lag screw was static or dynamic; Distal locking was used in 119 of 177 and not distal locking was used in 58 of 177 • Randomised = 435; losses = unknown; analysed for unplanned return to theatre = 429; analysed for other outcomes = 226 **Intervention group 2** • CHS (Smith & Nephew) • Randomised = 477; losses = unknown; analysed for unplanned return to theatre = 467; analysed for other outcomes = 234
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; operative fracture of the femur; later fracture of the femur; cut-out of implant (fracture dislocation); non-union (fracture healing); reoperation; wound infection; DVT; PE; length of hospital stay; mortality; institutional stay; walking function **Outcomes relevant to the review:** unplanned return to theatre (reported as reoperation; 6 months); complications: intra and postoperative fracture; cut-out (all at 6 months)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** 1990 to 1992

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details

Benum 1994 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Quote: "The randomization was done by drawing on among mixed envelopes containing information allocating the patient to either treatment." Comment: study authors do not report if envelopes are sealed, sequentially-numbered or opaque
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Report from one centre (Aune 1994) refers to treatment by "younger surgeons" and in consequence that "the learning curve becomes important". We have assumed from this information that surgeons may not be equally experienced using both implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	Because studies are reported in numerous abstracts with interim publications and later publications for only subsets of participants, we were concerned that attrition was not well-explained or justified.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	High risk	For most data, we have used information reported in an abstract, which we expected was not peer-reviewed and likely to be at high risk of bias.

Bridle 1991

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus DHS
Participants	**Total number of randomised participants:** 100 **Inclusion criteria:** intertrochanteric proximal femoral fractures **Exclusion criteria:** < 60 years of age **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1** (Gamma nail) • Age (mean): 81 years • Gender (M/F): 9/40

Bridle 1991 *(Continued)*

- Cognitive status (mental test score (mean)): 7
- ASA status (I/II/III/IV): 2/23/20/4
- Fracture classification (stable/unstable): n = 18/31

Intervention group 2 (DHS)

- Age (mean): 82.7 years
- Gender (M/F): 7/44
- Cognitive status (mental test score (mean)): 7
- ASA status (I/II/III/IV): 2/22/16/11
- Fracture classification (stable/unstable): n = 23/28

Note: study authors did not report smoking history; medication; BMI; preoperative waiting time; co-morbidities; mobility or place of residence

Interventions	**General details:** 4 senior surgeons experienced with closed nailing techniques; general anaesthesia (n = 87), spinal anaesthesia (n = 13); clinical follow-up 6 months **Intervention group 1** • Gamma intramedullary nail; all nails were short cephalomedullary nails. All lag screws were dynamic and distal locking was not used in any cases. • Randomised = 49; all losses due to death; analysed for all outcomes = 49 **Intervention group 2** • DHS (Straumann) • Randomised = 51; all losses due to death; analysed for all outcomes = 51
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union; reoperation (incomplete data); wound infection; wound haematoma; bronchopneumonia; pressure sore; PE; any medical complication; LOS; shortening of femur (leg) (no information); mortality; pain (no information); eventual discharge residence; patient mobility; length of follow-up: 6 months **Outcomes relevant to the review:** mortality (during hospital stay, 6 months); LOS; complications: intra- and postoperative fracture, pneumonia, cut-out, CVA, superficial infection, PE (all at 6 months) **Notes** • We did not include data for discharge destination, which were reported in a bar chart from which we could not confidently extract data. • We have included the data for wound infection as 'superficial infection'. • Study authors report data for LOS without SD and we did not include these data in meta-analysis; we reported these data in an appendix.
Notes	**Funding/sponsor/declarations of interest:** quote: "no benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article" **Study dates:** not reported **Note:** we noted some discrepancies between tables and text in the study report.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomised but no additional details

Bridle 1991 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeon performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote: "All the operations were performed by one of four senior surgeons, all experienced in closed nailing techniques."
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were balanced and explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Butt 1995

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** Gamma nail versus DHS

Participants	**Total number of randomised participants:** 95
	Inclusion criteria: trochanteric and subtrochanteric proximal femoral fractures
	Exclusion criteria: not reported
	Setting: single centre; orthopaedic hospital, UK
	Baseline characteristics
	Intervention group 1 (Gamma nail)
	• Age (mean (range)): 79 (55 to 92) years
	• Gender (M/F): 16/31
	• Cognitive status (mental test score (mean)): 6.8
	• Fracture classification (stable/unstable)
	  ○ Intertrochanteric: n = 18/16
	  ○ Subtrochanteric: n = 5/8

Butt 1995 *(Continued)*

Intervention group 2 (DHS)

- Age (mean (range)): 78 (47 to 101) years
- Gender (M/F): 13/35
- Cognitive status (mental test score (mean)): 6.9
- Fracture classification (stable/unstable)
  - Intertrochanteric: n = 12/14
  - Subtrochanteric: n = 3/4

Note: study authors did not report smoking history; medication; BMI; preoperative waiting time; co-morbidities; mobility or place of residence

Interventions	**General details:** standard surgical procedures; surgical experience is unknown; same surgeons did both operations **Intervention group 1** • Gamma nail (Howmedica); predominantly short nails; 3 cases that suffered further fractures were treated with long nails • Randomised = 47; no reported losses; analysed for all outcomes = 47 **Intervention group 2** • DHS (STRATEC); no further details reported • Randomised = 48; no reported losses; analysed for all outcomes = 48 **Notes** • Details regarding distal locking of nails were not reported in the manuscript. • Study authors did not report details for: surgeon experience, type of anaesthesia, prophylactic use of antibiotics or antithromboembolics, postoperative mobilisation and weight-bearing.
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; later fracture of the femur; cut-out of implant (incomplete data); non-union (time to union); reoperation (total inferred); wound infection; pneumonia; pressure sore; DVT; any medical complication; LOS; mortality; length of follow-up: 'to fracture union' (generally < 6 months) **Outcomes relevant to the review:** mortality (5 months); LOS; unplanned return to theatre; complications: postoperative periprosthetic fracture; DVT, MI, chest infection, UTI, superficial infection, CVA; plate/screw failure (reported as mechanical failure of implant); (follow-up time point not reported) **Notes** • Participants were followed up until satisfactory union occurred; time to union stated as (mean) 150 days for Gamma nails and 142 days for DHS, reported in analyses as 5 months • We have included data for wound infection as 'superficial infection'. • The study authors reported data for LOS without SD and we did not include these data in meta-analysis; we reported these data in an appendix.
Notes	**Funding/sponsor/declarations of interest:** quote: "No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article" **Study dates:** not reported **Note:** we noted that the Gamma nail technique was modified without apparent advantage after 37 participants were treated with a Gamma nail.

Risk of bias

Bias	Authors' judgement	Support for judgement

Butt 1995 *(Continued)*

Random sequence generation (selection bias)	High risk	Quote: "Patients admitted on even-numbered weeks were treated with a DHS and patients admitted on odd-numbered weeks were treated with a gamma nail."
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation because of methods used to randomise participants.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The same surgeons did both operations, but there was no mention of experience and interim modification of surgical technique by the manufacturers.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were balanced and explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Cai 2016

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: intramedullary versus extramedullary implants
Participants	**Total number of randomised participants:** 222 **Inclusion criteria:** stable, comminuted, intertrochanteric femoral fracture; > 65 years of age; the ability to walk independently (with or without an aid) prior to fracture; and sustainment of a low-energy injury with 24 hours prior to admission **Exclusion criteria:** a compound femoral fracture; < 65 years of age; a history of previous fracture; any contraindication to surgery; nonambulatory status prior to the presenting injury, or any other traumatic fracture **Setting:** single site; hospital; China **Baseline characteristics** (only for analysed participants) **Intervention group 1** (intramedullary)

Cai 2016 *(Continued)*

- Age (mean (range; SD)): 75.8 (65 to 100; ± 6.20) years
- Gender (M/F): 39/67
- ASA status (I/II/III): 3/53/50
- Preoperative waiting time (mean (SD)): 3.58 (± 1.57) days
- Fracture classification (Evans Type-I/Type-II): n = 30/76

Intervention group 2 (extramedullary)

- Age (mean (range; SD)): 75.9 (65 to 88; ± 6.06) years
- Gender (M/F): 29/63
- ASA status (I/II/III): 2/50/40
- Preoperative waiting time (mean (SD)): 3.61 (± 1.73) days
- Fracture classification (Evans Type-I/Type-II): n = 32/60

Overall

- Age (mean (range)): 75.9 (65 to 100) years
- Gender (M/F): 68/130

Note: study authors did not report baseline characteristics for: smoking history; medication; BMI; co-morbidities; mobility assessment; place of residence; or cognitive status/dementia

Interventions	**General details:** all surgeries were carried out by 3 surgeons, all of whom had more than 15 years of clinical experience (all were familiar with both techniques) **Intervention group 1** • Type not clearly defined. We assumed DHS from information in the introduction, but possibly at the discretion of the surgeon • Number randomised to group = 105; losses = 13 (11 unable to contact for "various reasons"; 2 discontinued intervention); analysed = 92 **Intervention group 2** • Type not clearly defined. We assumed PFNA and/or Gamma nails from information within the introduction and conclusion • Number randomised to group = 117; losses = unclear (10 unable to contact for various reasons; 1 discontinued intervention); analysed = 106 **Note:** study authors do not provide information on anaesthesia used, use of prophylactic antibiotics or antithromobotic medication, or rehabilitation/weight-bearing protocols
Outcomes	**Outcomes measured/reported by study authors:** operation time; blood loss; functional recovery; postoperative complications (superficial wound infection, deep wound infection, pneumonia, UTI, delayed union, non-union, cutting of lag screw, implant failure, electrolyte imbalance, hypoproteinaemia); mortality (available at 12 months) **Outcomes relevant to the review:** functional recovery; mortality (reported at 12 months); superficial wound infection, deep wound infection, pneumonia, UTI, delayed union, non-union
Notes	**Funding/sponsor/declarations of interest:** supported by the National Natural Science Foundation of China. Study authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of the article **Study dates:** 2011 to 2014

Risk of bias

Bias	Authors' judgement	Support for judgement

Cai 2016 *(Continued)*

Random sequence generation (selection bias)	Low risk	Randomised by coin toss
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	The study authors report that interventions were performed by senior surgeons who were equally experienced in using both types of study implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect blinding to influence detection bias for this outcome.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few participants were lost; these losses were balanced between groups, and reasons for loss were clearly explained.
Selective reporting (reporting bias)	Unclear risk	Study was retrospectively registered with a clinical trials register (ChiCTR-INQ-16009754; registered on 6 November 2016). It is not feasible to effectively assess risk of selective reporting bias with these retrospectively registered documents.
Other bias	Low risk	We identified no other sources of bias.

Calderon 2013

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFN versus DHS
Participants	**Total number of randomised participants:** 32 participants **Inclusion criteria:** 60 to 90 years of age; type II intertrochanteric fracture of Boyd and Griffin classification, < 48 hours from injury **Exclusion criteria:** previous fractures on limb or contralateral side which affected rehabilitation; pathological fractures; dementia; non-consent to participate. Also excluded were participants who failed to attend follow-up, participants with incomplete medical records and participants who withdrew from the trial. **Setting:** single centre; University Hospital, Mexico **Baseline characteristics** **Intervention group 1** (PFN)

Calderon 2013 *(Continued)*

- Age (mean): 79.8 years

Intervention group 2 (DHS)

- Age (mean): 81.3 years

Overall

- Age (mean): 80.5 years
- Gender (M/F): 8/24

Note: study authors did not specify: gender for each group; smoking history; medication; BMI; comorbidities; mobility assessment; place of residence; cognitive status/dementia; ASA status; preoperative waiting time; undisplaced/displaced

Interventions	**General details:** experience of surgeons not reported; clinical follow-up at 2, 4 and 8 weeks and 6 months after surgery; active and passive mobility from first postoperative day, then full weight-bearing as indicated by daily VAS assessment **Intervention group 1** • PFN; details regarding the length of nail used, proximal and distal locking were not reported in the study report • Randomised = 16; no losses reported **Intervention group 2** • DHS (Synthes) • Randomised = 16; no losses reported
Outcomes	**Outcomes measured/reported by study authors:** pain (VAS; range of scores not reported); incision size; intraoperative bleeding; length of surgery; HHS; time to start partial or total weight bearing; time to union; complications: reported on later fracture, "varus collapse" (without clinical implication); length of follow-up: 6 months (or 16 weeks; inconsistently reported in article) **Outcomes relevant to the review:** functional status (HHS; 6 months); pain (VAS at 6 months); postoperative fracture (6 months) **Note:** study authors reported HHS without SD and we did not include these data in meta-analysis; we reported these data in an appendix
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "patients .... were randomly divided into two groups" Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.

Calderon 2013 *(Continued)*

Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Carulli 2017

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: PFN versus DHS
Participants	**Total number of randomised participants:** 140 **Inclusion criteria:** adults with trochanteric fracture (31A1 or 31A2), able to give full consent **Exclusion criteria:** people with 31A3 fracture; psychiatric diseases; any form of neurologic deficit to lower limbs; any contraindication to surgery **Setting:** single centre; university hospital; Italy **Baseline characteristics** **Intervention group 1** (intramedullary) • Age (mean (SD)): 81.62 (± 7.82) years • Gender (M/F): 29/42 • Comorbidities: n = 55 had comorbidities, mostly related to cardiologic, metabolic, and circulatory issues • Fracture classification (31.A1/31.A2): n = 25 (35.21%)/46 (64.69%) **Intervention group 2** • Age (mean (SD)): 83.41 (± 7.90) years • Gender (M/F): 25/44 • Comorbidities: n = 54 had comorbidities (no additional detail) • Fracture classification 31.A1/31.A2): n = 28 (40.57%)/41 (59.43%)

Carulli 2017 *(Continued)*

	Notes • Study authors report no baseline data for: smoking history, medication, BMI, mobility assessment, cognitive status, ASA status or preoperative waiting times • Study authors report that 38 participants lived alone with support or with other relatives and with some support, and the remainders lived in residential. However, it is unclear whether this is reported for all participants or only those in the intramedullary group.
Interventions	**General details:** all participants were studied by conventional radiology in the Emergency Room and received antibiotic and antithromboembolic prophylaxis. For postoperative care: all participants given 2 bags of heterologous blood. For rehabilitation, POD 1 - passive motion in bed. POD 2 - allowed to sit in bed with active knee and ankle exercises. POD3 - assisted standing and gait exercises. Subjects sent to rehabilitation facilities to complete functional recovery **Intervention group 1** • PFNA (Synthes); all nails used were 200 mm long; cephalic fixation was performed with a helical blade; nail diameter 10 mm or 11 mm; all nails were distally locked statically • Randomised = 71; losses = 5 (2 died; 1 did not go to outpatient appointment at 3 months; 2 did not attend last follow-up); analysed for mortality = 71; analysed for other outcomes at 12 months = 66 **Intervention group 2** • Dynamic Hip Screw (DHS) (Synthes) • Randomised = 69; losses = 7 (4 died; 1 did not go to outpatient appointment at 3 months; 2 did not attend last follow-up); analysed for mortality = 69; analysed for other outcomes at 12 months = 62 **Note:** study authors do not report number of surgeons (and their skills or experience)
Outcomes	**Outcomes measured/reported by study authors:** mortality (at 12 months); blood loss; complications (pulmonary infection, DVT, UTI, superficial wound infection; mechanical complications - spiral blade migration, lateral blade protrusion, migration of plate screws, failure); LOS; walking with partial or full weight-bearing at discharge; independent walking at 3 months; restore walking activity and health status to pre-fracture level; HRQoL **Outcomes relevant to the review:** HRQoL (SF12, PCS and MCS at 12 months); mobility (independent walking at 3 months; restore walking activity and health status to pre-fracture level at 12 months); mortality (at 12 months); unplanned return to theatre (at 12 months); pain (at 12 months); LOS; discharge destination; complications: plate/screw failure (reported as implant failure), DVT, PE, UTI, pneumonia, superficial wound infection(all at 12 months) **Note:** for all outcomes (except mortality), we have assumed that data is reported for 66 in the intramedullary group and 62 in the extramedullary group
Notes	**Funding/sponsor/declarations of interest:** funding not reported. "All authors disclose any financial and personal relationships with other people or organizations that could have inappropriately influenced or biased their work" - these disclosures are not detailed in the study report **Study dates:** January 2007 to December 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes. Study authors do not report if envelopes are opaque and sequentially numbered.

Carulli 2017 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were balanced and mostly explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Chechik 2014

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: EPFN versus DHS
Participants	**Total number of randomised participants:** 60 **Inclusion criteria:** unilateral extracapsular (31A1 and 31A2) hip fracture following low-energy trauma **Exclusion criteria:** < 60 years of age, pathologic fractures, life-threatening disease (ASA ≥ 4), subtrochanteric or reverse oblique fracture patterns (31A3), inability to give informed consent due to dementia or confusional state, previous fracture or previous surgery of the affected leg **Setting:** single centre; hospital; Israel **Baseline characteristics** **Intervention group 1** (intramedullary) • Age (mean (SD)): 83.1 (± 5.7) years • Gender (M/F): 6/21 • BMI (mean (SD)): 24.9 (± 4.8) kg/m^2

Chechik 2014 *(Continued)*

- Comorbidities (type: n): heart disease: 7; diabetes: 8; renal failure: 4; Parkinson's disease: 0
- Mobility assessment (Parker and Palmer, mean (SD)): 6.34 (± 2.64)
- Place of residence (n): own home: 24; nursing institution: 5
- Dementia: n = 6
- ASA status (mean (SD)): 2.31 (± 0.54)
- Preoperative waiting time, from fall to surgery (mean (SD)): 45 (± 25) hours
- Fracture classification (31A1/31A2): n = 10/19

Intervention group 2 (extramedullary)

- Age (mean (SD)): 83.1 (± 6.7) years
- Gender (M/F): 8/23
- BMI (mean (SD)): 25.5 (± 4.7) kg/m^2
- Comorbidities (type: n): heart disease: 7; diabetes: 6; renal failure: 3; Parkinson's disease: 2
- Mobility assessment (Parker and Palmer, mean (SD)): 6 (± 2.73)
- Place of residence (n): own home: 25; nursing institution: 6
- Dementia: n = 3
- ASA status (mean (SD)): 2.26 (± 0.63)
- Preoperative waiting time, from fall to surgery (mean (SD)): 55 (± 35) hours
- Fracture classification (31A1/31A2): n = 10/21

Note: study authors report no baseline characteristics for: smoking history or medication

Interventions

General details: IV antibiotics given immediately before surgery; spinal anaesthesia (15) and general anaesthesia (45); low-molecular weight heparin for 6 weeks after surgery. After surgery, participants were allowed to weight-bear as tolerated; all were encouraged to begin walking with a frame on POD 1.

Intervention group 1

- EPFN (Fixion; HMB Medical Technologies, Herzliya, Israel). Either a 10 mm or a 12 mm nail with a 130-degree nail-peg angle was used; the nail was inflated to a maximum diameter of 16 mm or 19 mm, respectively, at a pressure of 70 mmHg to achieve static distal locking; the head peg was inflated with a pressure of 100 mmHg to 140 mmHg and then locked at the nail peg interface.
- Randomised = 29 losses at end of follow-up = 3 (owing to death); analysed for mortality, CVA, wound discharge, acute coronary syndrome and LOS = 29; analysed for other outcomes = 26

Intervention group 2

- CHS (Smith & Nephew)
- Randomised = 31; losses at end of follow-up = 5 (owing to death); analysed for mortality, CVA, wound discharge, acute coronary syndrome and LOS = 31; analysed for other outcomes = 29

Note: nail length was not reported in the manuscript; the expandable PFN is manufactured in two lengths, 220 mm or 340 mm

Outcomes

Outcomes measured/reported by study authors: mortality (30 days); CVA (time point described as 'early postoperative'); LOS (days); reoperation (1 year); discharge location (1 year); mobility score (Parker and Palmer; 1 year); functional outcome at 1 year (HHS; total mean score - also reported as pain, support, distance, and limp); periprosthetic fracture; ADL (used Jensen's independence score; at 1 year); pain (measured as a separate category in HHS); loosening of prosthesis (plate/screw failure; 1 yr); wound infection (defined as wound discharge); acute coronary syndrome; cut-out; plate screw failure; independence (Jensen's score); change of independence; femur shortening; reduced offset; shaft medialization; heterotopic ossification; blood transfusion (reported as mean units); radiation time, scar length, quality of reduction, intra-operative fracture, acute coronary syndrome, CVA, wound discharge, hospitalisation

Outcomes relevant to the review: ADL (Jensen's independence score; at 12 months); functional outcome (HHS; at 12 months); mobility score (Parker; 12 months); mortality (30 days and 12 months); unplanned return to theatre (12 months); pain (using HHS pain domain; at 12 months); LOS; complica-

Chechik 2014 *(Continued)*

	tions: plate/screw failure; cut-out; postoperative fracture; CVA; superficial infection (defined as wound discharge); MI (all at 12 months)
Notes	**Funding/sponsor/declarations of interest:** funding not reported; study authors declare no conflicts of interest **Study dates:** June 2008 to February 2010

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Low risk	Use of sealed envelopes, and study authors report that allocation was strictly maintained
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were balanced and mostly explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. We identified a clinical trials register report which we expected was for this study (NCT00686023; registered in May 2008), but this report indicated that the study was "not yet recruiting" and we could not be certain whether this was the same study. The clinical trials register report listed only one outcome (mortality).
Other bias	Low risk	We identified no other sources of bias.

Chen 2018

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFNA versus SHS
Participants	**Total number of randomised participants:** 36 **Inclusion criteria:** meeting the international definition of the elderly and diagnostic criteria for intertrochanteric fracture of femur **Exclusion criteria:** people with the following conditions: HIV; coagulation disorders; hepatic and renal insufficiency; severe circulatory system diseases; mental disorder **Setting:** single centre; orthopaedic hospital; China **Baseline characteristics** **Intervention group 1** (PFNA) • Age (mean (SD)): 63.2 (± 2.3) years • Gender (M/F): 10/8 • Fracture classification (Evan-Jensen I/II/III/IV): 4/5/7/2 • Complications: n = 5 (includes cardio-cerebrovascular disease, diabetes and respiratory) **Intervention group 2** (SHS) • Age (mean (SD)): 64.3 (± 1.9) years • Gender (M/F): 9/9 • Fracture classification (Evan-Jensen I/II/III/IV): 5/5/6/2 • Complications: n = 6 (includes cardio-cerebrovascular disease, diabetes and respiratory) **Note:** study authors did not report smoking history; medication; BMI; preoperative waiting time; mobility, cognitive
Interventions	**General details:** combined spinal-epidural anaesthesia; conventional anti-inflammatory treatment after operation, and antithrombotic drugs were given on day one; no details reported regarding experience of surgeons or familiarity with interventions **Intervention group 1** • PFNA, placed through a guiding needle, adjusted under X-ray fluoroscopy, with an angle of about 13° with the femur • Randomised = 18 **Intervention group 2** • SHS, introduced with an anteversion of 15° below the lesser trochanter tip of femur under X-ray fluoroscopy • Randomised = 18 **Note:** study authors do not report whether surgeons are experienced with both implants
Outcomes	**Outcomes measured/reported by study authors:** intraoperative bleeding; length of surgery; LOS; short-term complications; time to weight-bearing (partial/full); fracture healing time; functions (Sanders: 55 to 60 = excellent; 45 to 54 = good; 35 to 44 = poor; < 34 = fail) **Outcomes relevant to the review:** function (Sanders: reported as excellent/good: 55 to 60, excellent; 45 to 54, good; at 6 months); LOS

Chen 2018 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** funding not reported; study authors declare no conflicts of interest **Study dates:** June 2016 to June 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Random number table used, but no further details provided
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors describe the experience level of surgeons in each group, and we noted these were evenly balanced. However, it is unclear if each surgeon was equally experienced with both types of implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Davis 1988

Study characteristics

Methods	RCT; parallel design **Review comparison group:** Kuntscher-Y nail versus SHS
Participants	**Total number of randomised participants:** 230 **Inclusion criteria:** intertrochanteric proximal femoral fractures; fit for surgery **Exclusion criteria:** < 50 years of age; pathological and Paget's fractures

Davis 1988 *(Continued)*

Setting: 2 orthopaedic hospitals, UK

Baseline characteristics

Intervention group 1 (nail)

- Age (mean (SD)): 80.2 (± 9.4) years
- Gender (M/F): 27/89
- Mobility assessment (walking ability (1 = independent to 6 = bedridden), mean (SD)): 3.0 (± 1.49)
- Cognitive status (mental test score (mean (SD)): 6.9 (± 4.8)
- Fracture classification (n)
  - Two part displaced = 22
  - Three part lateral = 28
  - Three part medial = 18
  - Complex = 35
  - Associated subtrochanteric = 9
  - Basi-trochanteric = 4

Intervention group 2 (SHS)

- Age (mean (SD)): 81 (± 11.4) years
- Gender (M/F): 13/101
- Mobility assessment (walking ability (1 = independent to 6 = bedridden), mean (SD)): 3.1 (± 1.49)
- Cognitive status (mental test score (mean (SD)): 7.4(± 4.7)
- Fracture classification (n)
  - Two part displaced = 13
  - Three part lateral = 22
  - Three part medial = 7
  - Complex = 56
  - Associated subtrochanteric = 11
  - Basi-trochanteric = 5

Overall

- Age (mean (SD)): 80.6 (± 9.9) years
- Gender (M/F): 40/190
- Mobility assessment (walking ability (mean (SD)): 3.05 (± 1.49)
- Cognitive status (mental test score (mean (SD)): 7.15 (± 4.8)
- Fracture classification (n)
  - Two part displaced = 35
  - Three part lateral = 50
  - Three part medial = 25
  - Complex = 91
  - Associated subtrochanteric = 20
  - Basi-trochanteric = 9

Note: study authors did not report smoking history; medication; BMI; preoperative waiting time; co-morbidities

Interventions	**General details:** general or spinal anaesthetic; prophylactic antibiotics image intensification; weight-bearing encouraged after 48 hours; clinical follow-up at 6 weeks and 3, 6 and 12 months; operations performed by consultants or trainees

Intervention group 1

- Kuntscher-Y nail; the U-shaped blade is inserted through the lateral cortex of the femur into the femoral neck and then the intramedullary nail is inserted through the greater trochanter and through blade into the intramedullary canal of the femur; the Kuntscher-Y nail cannot be locked distally

Davis 1988 *(Continued)*

- Randomised = 116; analysed for mortality, unplanned return to theatre, adverse events = 116; analysed for mobility = 68

Intervention group 2

- SHS, no further details reported
- Randomised = 114; analysed for mortality, unplanned return to theatre, adverse events = 114; analysed for mobility = 73

Note: study authors do not report whether surgeons are experienced with both implants

Outcomes	**Outcomes measured/reported by study authors:** LOS; LOS and convalescence; mortality (1 month and 6 months); radiographic healing time; time to weight bearing; Salvati and Wilson score; functional deficit; power and motion at hip; knee mobility; time until painless mobilisation and failure to regain pre-fracture mobility; complications: infection, UTI, chest infection, venous thromboembolic phenomena; implant failure; cut-out; LOS (not reported by group); Mental Test Score **Outcomes relevant to the review:** mortality (12 months); unplanned return to theatre; mobility (failure to regain pre-fracture mobility); LOS; complications: deep infection, superficial infection, UTI, chest infection, DVT, implant failure (reported as bend and uncoupling); cut-out (all at 12 months) **Notes** • The reasons for unplanned return to theatre were: non-union, cut-out and infection. • We included data described as thromboembolism with data from other studies for DVT. • The study authors reported data for LOS without SD and we did not include these data in meta-analysis; we reported these data in an appendix.
Notes	**Funding/sponsor/declarations of interest:** funded by the Northern Regional Health Authority **Study dates:** June 1983 to May 1985 **Note:** we noted that the nail used was described as an experimental device which is not available commercially. This outdated implant is now superseded by newer intramedullary nails that have improved instrumentation and the capacity for distal locking to reduce the risk of limb shortening.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "using random numbers table"
Allocation concealment (selection bias)	Low risk	Quote: "For each trial number, the name of the allocated fixation device was stored in an opaque sealed envelope which was opened only after a patient had been assigned this trial number."
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance. The study authors do not report whether surgeons were equally experienced in using the study implants.
Other performance bias: surgeon experience of both implants	Unclear risk	Quote: "Similar proportions of each operation were performed at the two hospitals, by consultants or trainee surgeons." Comment: study authors do not report whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias)	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.

Davis 1988 *(Continued)*

Clinically-assessed subjective outcomes		
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses are explained by death, which is expected in this population. We noted some small discrepancies in denominators for some outcomes but we did not expect this would significantly affect the data.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Dujardin 2001

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** mini-invasive static intramedullary nail versus SHS

Participants	**Total number of randomised participants:** 60
	
	Inclusion criteria: intertrochanteric proximal femoral fracture (stable and unstable fractures), informed consent, ≥ 60 years of age; surgery within first 2 days after fracture
	
	Exclusion criteria: pathological; lower limb arteriopathy; fractures extending to the diaphysis; previous lesions of the hip; cutaneous lesions; abnormal calcium or phosphorus metabolism and no consent
	
	Setting: single centre; orthopaedic hospital; France
	
	Baseline characteristics
	
	Intervention group 1 (intramedullary nail)
	
	• Age (mean (SD)): 83 (± 9.4) years
	• Gender (M/F): 6/24
	• Mobility assessment (walking (Salvati 1973), mean (SD)): 5.4 (± 2.9)
	• ASA status (mean (SD)): 2.1 (± 0.7)
	• Fracture classification (stable/unstable): n = 8/22
	• Additional information
	  ◦ Function (mean (SD)): 4.3 (± 3.1)
	  ◦ Singh index (Singh 1970) (mean (SD)): 2.9 (± 0.9)
	
	Intervention group 2 (SHS)
	
	• Age (mean (SD)): 84 (± 6.2) years
	• Gender (M/F): 6/24
	• Mobility assessment (walking (Salvati 1973), mean (SD)): 6.5 (± 2.2)
	• ASA status (mean (SD)): 2.3 (± 0.5)
	• Fracture classification (stable/unstable): n = 14/16

Dujardin 2001 *(Continued)*

- Additional information
  - Function (mean (SD)): 5.1 (± 2.9)
  - Singh index (Singh 1970) (mean (SD)): 2.5 (± 0.9)

Note: study authors did not report smoking history; medication; BMI; cognitive status; preoperative waiting time; comorbidities

Interventions	**General details:** traction table; 6-week thromboembolic prophylaxis with low-molecular-weight heparin; postoperative care identical in both groups; weight-bearing authorised when no pain existed; all operations were undertaken by 2 surgeons with experience of the surgical technique; 1 surgeon did all the SHS operations and the other did all the nail operations; both described as a senior surgeon; type of anaesthesia is at the discretion of attending anaesthetist **Intervention group 1** • Cephalomedullary nail (an experimental device used only for this study and not available commercially); 170 mm long; 12 mm diameter; cephalic fixation is achieved with 2 converging screws resulting in static proximal fixation; all nails were locked distally • Randomised = 30; no reported losses **Intervention group 2** • SHS (Smith & Nephew) • Randomised = 30; no reported losses
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; mean units blood transfused; radiographic screening time; non-union; time to union; early postoperative complications (infection, thromboembolism, further operation); pneumonia; pressure sores; all medical complications; LOS; varus deformity (reported for the nail group); angular restoration; mortality; various aspects of hip function, including pain, power and mobility, were measured using the Salvati and Wilson score; pain; time to effective weight-bearing; hip function; knee mobility; length of follow-up: 6 months **Outcomes relevant to the review:** mortality (1 and 6 months); pain (Salvati and Wilson score; at 6 weeks); LOS **Notes** • Study authors state that "No early postoperative complications were noted". • The study authors reported data for LOS without SD and we did not include these data in meta-analysis; we reported these data in an appendix.
Notes	**Funding/sponsor/declarations of interest:** no external funding **Study dates:** not reported **Note:** study authors state that the experimental nail is not available commercially

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias)	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.

Dujardin 2001 *(Continued)*
All outcomes

Other performance bias: surgeon experience of both implants	Low risk	All operations were undertaken by two surgeons with experience of the surgical technique; one surgeon did all the SHS operations and the other did all the nail operations.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	All losses were explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Eceviz 2020

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: cephalomedullary nail versus SHS
Participants	**Total number of randomised participants:** 64 **Inclusion criteria:** basicervical fracture, ≥ 65 years of age, isolated fracture, ability to walk independently (with or without an aid) before fracture, fracture that had occurred < 1 week prior to admission **Exclusion criteria:** history of ipsilateral femoral fracture, fracture due to malignancy, limited life expectancy due to medical comorbidities, any contraindication to surgery, diagnosed dementia, any other traumatic fracture **Setting:** tertiary hospital; single centre; Turkey **Baseline characteristics** **Intervention group 1** (intramedullary) • Age (mean (SD)): 81.34 (± 6.92) years • Gender (M/F): 15/14 • Mobility score (average): 8.5 • Preoperative waiting time (mean (SD)): 5.76 (± 3.47) days • Additional information ◦ Barthel index (average): 93.0 **Intervention group 2** (extramedullary) • Age (mean (SD)): 80.11 (± 8.23) years

Eceviz 2020 *(Continued)*

- Gender (M/F): 11/16
- Mobility score (average): 8.4
- Preoperative waiting time (mean (SD)): 5.37 (± 3.47) days
- Additional information
  - Barthel Index (average): 94.5

Note: study authors report no baseline characteristics for: smoking history, medication, BMI, comorbidities, place of residence, cognitive status, ASA status, or fracture classification

Interventions	**General details:** 2 senior surgeons (> 10 years of surgical experience in treating basicervical fractures and familiar with both surgical techniques); closed reduction under fluoroscopic guidance on a traction table; postoperatively, all patients were allowed immediate weight-bearing as tolerated, regardless of the method of fixation; clinical follow-up at 6 weeks, 3 months, 6 months, and 12 months **Intervention group 1** • Cehphalomedullary nail (Profin®); manufactured nails lengths are 220 mm and 250 mm (specific lengths of nails used in the study were not reported); cephalic fixation was performed with 2 dynamic screws; all nails were locked distally • Randomised = 32; losses = 3 (1 unable/unwilling to continue; 2 died); analysed for mortality = 32; analysed for other outcomes = 29 **Intervention group 2** • Dynamic hip screw; secured to femur with 3-hole plate • Randomised = 32; losses - 5 (1 unable/unwilling to continue; 4 died); analysed for mortality = 32; analysed for other outcomes = 27 **Note:** study authors do not report type of anaesthesia
Outcomes	**Outcomes measured/reported by study authors:** mobility score (0 to 9), HHS; ADL (using modified BI, range 0 to 100); tip apex distance and fracture settling, quality of reduction; mortality; revision surgery; wound infections **Outcomes relevant to the review:** ADL (modified BI range 0 to 100; at 12 months); functional status (HHS, at 12 months); mobility score (Parker 1993, 6 weeks); mortality (12 months); unplanned return to theatre (revision surgery; at 12 months); superficial infections (reported as surgery-related infections or wound complications; at 12 months) **Note:** the study authors reported data for mobility without distribution values; we included these data in an appendix.
Notes	**Funding/sponsor/declarations of interest:** no funding; study authors declare no conflicts of interest **Study dates:** January 2016 to January 2018

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The patients were randomly allocated to a study group by permuted blocks of randomly mixed sizes and stratification according to the type of surgery (CMN or SHS)"
Allocation concealment (selection bias)	Low risk	Quote: "Randomization was applied using pre-prepared randomisation cards, which were placed in opaque, sealed envelopes and given to the surgeons to open just prior to surgery, and the designated procedure was then performed"
Blinding of participants and personnel (performance bias)	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.

Eceviz 2020 *(Continued)*

All outcomes		
Other performance bias: surgeon experience of both implants	Low risk	Surgeons were experienced with both implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	Low risk	Quote: "The clinical follow-up evaluations were performed by two independent orthopaedic surgeons who had access to all the patients' files and documents. They were also blinded to the preceded treatment." Comment: participants were assigned a four-digit number to conceal their identity and the radiographs were kept in digital folders.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were balanced and mostly explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors reported registration with a clinical trials register (NCT04240743); however, this registration was made after completion of the study (in January 2020) and it was not feasible to effectively assess risk of selective reporting bias from these documents.
Other bias	Low risk	We identified no other sources of bias.

Ekstrom 2007

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFN versus the Medoff sliding plate
Participants	**Total number of randomised participants:** 210 **Inclusion criteria:** unstable trochanteric fracture classified 3-5 (Jensen 1981); AO/OTA: 31 A2.1-3 and A3.1-3; subtrochanteric fracture classified as AO/OTA: 32 A1.1 and B1.1 (Seinsheimer 1978); adults with a closed growth plate and an unstable trochanteric fracture or a subtrochanteric fracture with the most distal fracture ending < 5 cm distal to the lesser trochanter **Exclusion criteria:** people with stable trochanteric fractures, high-energy trauma, pathological fractures, previous surgery to the proximal femur, daily steroids of more than 10 mg of prednisolone, ongoing chemotherapy, irradiation treatment, presence of degenerative osteoarthrosis of the injured hip **Setting:** two orthopaedic hospitals, Sweden **Baseline characteristics** (only for 203 participants) **Intervention group 1** (PFN) • Age (mean (range)): 82 (48 to 96) years

Ekstrom 2007 *(Continued)*

- Gender (M/F): 24/76
- Mobility assessment (without aid/2 crutches or frame/human support): n = 65/34/1
- Place of residence (own home/nursing home/institution): n = 81/8/11
- Fracture classification (n)
  - Trochanteric (Jenson, type 3/4/5): 16/10/56
  - Subtrochanteric (Seinsheimer, type 1/2/3/4/5): 0/0/1/8/9

Intervention group 1 (Medoff sliding plate)

- Age (mean (range)): 82 (52 to 97) years
- Gender (M/F): 25/75
- Mobility assessment (without aid/2 crutches or frame/human support): n = 62/35/3
- Place of residence (own home/nursing home/institution): n = 74/16/10
- Fracture classification (n)
  - Trochanteric (Jenson, type 3/4/5): 11/19/57
  - Subtrochanteric (Seinsheimer, type 1/2/3/4/5): 0/0/5/1/7

Note: study authors did not report smoking history; medication; BMI; cognitive status; pre-operative waiting time; or comorbidities

Interventions	**General details:** preoperative antibiotics; subcutaneous low-molecular heparin (thromboembolic prophylaxis) for 7 days; spinal anaesthesia was used, although 13 patients had general anaesthesia and 1 patient had a combination of both; patients were mobilised according to the treatment protocol at the 2 hospitals; weight-bearing as tolerated or restricted weight-bearing; clinical follow up at 6 weeks, 4 and 12 months; operations performed by 43 different surgeons, consultants or trainees; 2 senior consultants with extensive experience with both implants gave theoretical and practical instructions before start of study **Intervention group 1** • PFN (STRATEC, Switzerland); 240 mm long nail, available in 10, 11 and 12 mm diameters; a shaft angle of 130 degrees was used; cephalic fixation was performed with 2 screws; distal locking of the PFN was not reported • Randomised = 110; losses/exclusions = 5 (excluded due to improper inclusion of 1 femoral shaft fracture, 2 pathological fractures, 2 fractures treated with another method); other losses - see Notes; analysed for mortality, unplanned return to theatre and complications = 105; analysed for mobility and function outcomes at 4 months = 75; analysed for mobility and function outcomes at 12 months = 64 **Intervention group 2** • Medoff Sliding Plate (Medpac Inc., Calafornia, USA); 4- or 6-hole plate used in biaxial mode for trochanteric fractures and uni-axial mode for the subtrochanteric fractures; locking set screw was used in all subtrochanteric fractures to prevent dynamisation of the femoral neck screw and direct dynamisation along the shaft of the femur • Randomised = 100; losses/exclusions = 2 (excluded due to 1 Jensen-Michaelsen fracture and 1 due to treatment with another method); other losses - see Notes; analysed for mortality, unplanned return to theatre and complications = 98; analysed for mobility and function outcomes at 4 months = 71; analysed for mobility and function outcomes at 12 months = 56 **Note:** loss to follow-up was reported for the overall group, the main reason being failure to attend due to general health and death. At 4 months, 28% did not attend follow-up examinations; at 12 months, 41% did not attend follow-up examinations.
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; radiographic screening time; cut-out of implant; non-union; operative fracture of the femur; later fracture of the femur; other fracture healing complications; reoperation; wound infection; wound haematoma; LOS; mortality; failure to return to pre-fracture residential status; pain; inability to walk 15 metres; inability to rise from the chair; inability to climb a curb; need to use walking aids; abductor strength

Ekstrom 2007 *(Continued)*

Outcomes relevant to the review: mortality (12 months); mobility (categorical: walking without crutch/1 crutch; 1 crutches/Zimmer frame; 2 human support; unable/refused; 4 and 12 months); pain (4 and 12 months); unplanned return to theatre (12 months); complications: infection; postoperative fracture; cut-out (all at 12 months)

Notes

- We have included data described as wound infection as 'superficial infection'.
- Data for pain were reported without SD, we reported these in an appendix.

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "based on a computer generated list. Randomization was stratified according to trochanteric or subtrochanteric fractures."
Allocation concealment (selection bias)	Low risk	Randomised "using consecutive numbered and sealed envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Quotes: "Surgery was undertaken by 43 different surgeons employed as regular staff at the two hospital", "two senior consultations ... with extensive experience and familiar with both surgical methods, gave theoretical and practical instructions before the start of the study" Comment: we did not expect that this provided sufficient protection against performance bias.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	Large loss to follow-up at 12 months. Reasons are not reported by group, and explained by "general health problems and death"
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.

Ekstrom 2007 *(Continued)*

Other bias	Low risk	We identified no other sources of bias.

Giraud 2005

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Targon PFN versus DHS
Participants	**Total number of randomised participants:** 60 **Inclusion criteria:** intertrochanteric proximal femoral fracture (stable and unstable fractures: AO 31-A1, A2 and A3) **Exclusion criteria:** not reported **Setting:** single centre; orthopaedic hospital; France **Baseline characteristics** **Intervention group 1** (Targon PFN) • Age (mean (SD, range)): 81 (± 12.8, 23 to 86) years • Gender (M/F): 6/28 • ASA status (I/II/III/IV): 1/9/20/4 • Fracture classification (31A1/A2/A3): n = 11/20/3 **Intervention group 2** (DHS) • Age (mean (SD, range)): 82 (± 9.8, 47 to 97) years • Gender (M/F): 8/18 • ASA status (I/II/III/IV): 2/8/16 • Fracture classification (31A1/A2/A3): n = 14/11/1 **Overall** • Gender (M/F): 14/46 • Fracture classification (stable/unstable): n = 31/29 **Notes** • Study authors did not report smoking history; medication; BMI; place of residence; cognitive status; preoperative waiting time; or comorbidities • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups
Interventions	**uGeneral details:** experience of surgeons is unknown **Intervention group 1** • Targon PFN (B. Braun Ltd, Tuttlingen, Germany); surgical procedures and implant details not reported; length of nails was not reported however it is highly probable that all nails used were short nails; details of distal locking of nails was not reported; cephalic fixation is performed with a screw and a pin • Randomised = 34; no reported losses **Intervention group 2** • DHS (Synthes)

Giraud 2005 *(Continued)*

- Randomised = 26; no reported losses

Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; cut-out of implant; later fracture of the femur; reoperation; wound infection (none); pneumonia (pulmonary congestion: "Pulmonaire"); DVT; LOS; mortality; time to walking; HHS; length of follow-up: 3 months **Outcomes relevant to the review:** LOS; mortality (at 3 months); unplanned return to theatre (due to cut-out); complications: postoperative fracture; cut-out; deep infection; non-union; pneumonia; DVT
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** December 2003 and June 2004 **Note:** additional information (on methods of randomisation and data for mortality and complications) supplied by study authors

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random numbers table
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Goldhagen 1994

Study characteristics

Goldhagen 1994 *(Continued)*

Methods	Quasi-RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus CHS
Participants	**Total number of randomised participants**: 75 **Inclusion criteria:** adults; trochanteric and subtrochanteric proximal femoral fractures; fracture amenable to treated with Gamma nail or CHS **Exclusion criteria:** previous ipsilateral hip fracture, hip surgery or congenital abnormality **Setting:** single centre; orthopaedic hospital, USA **Baseline characteristics (overall)** • Age: median 78 years (range 28 to 91 years) • Gender (M/F): 22/50 • Preoperative waiting time: 93% of patients had surgery within 48 hours **Baseline characteristics** **Intervention group 1** (Gamma nail) • Mobility assessment (ambulatory status): community: n = 24; community with aid: n = 5; household: n = 7 • Fracture classification (intertrochanteric/subtrochanteric): 28/6 **Intervention group 2** (CHS) • Mobility assessment (ambulatory status): community: n = 33; community with aid: n = 5; household: n = 1 • Fracture classification (intertrochanteric/subtrochanteric): 34/4 **Notes** • Study authors did not report smoking history; medication; BMI; place of residence; cognitive status; preoperative waiting time; comorbidities • One pathological fracture included • Approximately 50% were stable
Interventions	**General details:** prophylactic antibiotics and DVT; physical therapy commenced on the first or second POD; weight-bearing as tolerated; clinical follow-up minimum of 6 months; experience of surgeons is not reported **Intervention group 1** • Gamma nail; nail length short; cephalic fixation was performed with a single screw locked dynamically; all nails were locked distally. • Randomised = 35; losses = 1 (death); analysed for mobility = 29 **Intervention group 2** • CHS; no details reported • Randomised = 40; losses = 2 (death); analysed for mobility = 36
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; radiographic screening time; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union; re-operation; LOS; mortality; pain at follow-up; non-return to previous residence; impaired walking **Outcomes relevant to the review:** mortality (6 months); mobility (ambulatory status, categorical: community, community with aid or household; mean follow-up of 6.4 months); unplanned return to theatre; perioperative fracture; cut-out; LOS

Goldhagen 1994 *(Continued)*

Notes

- The study authors reported LOS without distribution values and we did not include these data in meta-analysis; we reported these data in an appendix.
- We reported categorical outcome data for mobility in an appendix.

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** January 1990 to January 1991

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: " ..fractures ..were prospectively randomized into two groups according to their medical record number."
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation because of the methods used to allocate participants to groups.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Study authors refer to "a significant learning curve for the GN [Gamma nail]", and a "multiplicity of operating surgeons". We expected that surgeons were not all equally experienced with each implant.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were due to death, which is expected in this population. Although we noted some small discrepancies in denominators in some outcomes, we did not expect these to influence data.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Gou 2013

Study characteristics

Gou 2013 *(Continued)*

Methods	RCT; parallel design **Review comparison group:** PFNA versus PCCP

Participants	**Total number of randomised participants:** 90
	
	Inclusion criteria: > 60 years old; intertrochanteric fractures (type 31-A1 and 31-A2 based on OTA classification); Evans stable and unstable; ASA status score of I to IV
	
	Exclusion criteria: subtrochanteric fractures (type 31A3 in OTA classification); ASA V; existing or previous fractures in the same or contralateral hip; injuries that could affect the outcome measures; abnormalities that could affect the outcome measures
	
	Setting: single centre; orthopaedic hospital, China
	
	Baseline characteristics
	
	Intervention group 1 (PFNA)
	
	• Age (mean (SD)): 74.2 (± 8.8) years
	• Gender (M/F): 19/26
	• Comorbidities (n)
	  ◦ Hypertension and cardiovascular diseases = 35
	  ◦ Diabetes mellitus = 19
	  ◦ Osteoporosis = 7
	  ◦ Sequelae of cerebral infarction = 2
	  ◦ Pulmonary infection = 3
	  ◦ Chronic renal insufficiency = 0
	• Mobility assessment (pre-injury walking score, mean (SD)): 7.6 (± 2.3)
	• ASA status (I/II/III/IV): 7/12/21/5
	• Fracture classification (A1/A2; stable/unstable): n = 22/23; 18/27
	
	Intervention group 2 (PCCP)
	
	• Age (mean (SD)): 71.6 (± 7.5) years
	• Gender (M/F): 16/29
	• Comorbidities (n)
	  ◦ Hypertension and cardiovascular diseases = 33
	  ◦ Diabetes mellitus = 16
	  ◦ Osteoporosis = 5
	  ◦ Sequelae of cerebral infarction = 2
	  ◦ Pulmonary infection = 2
	  ◦ Chronic renal insufficiency = 1
	• Mobility assessment, pre-injury walking score (mean (SD)): 7.4 (± 2.9)
	• ASA status (I/II/III/IV): 6/13/19/7
	• Fracture classification (A1/A2; stable/unstable): n = 18/27; 23/22
	
	Notes
	
	• The study authors did not report smoking history; medication; BMI; place of residence; cognitive status; or preoperative waiting time.
	• No differences in prognostic variables were reported as statistically significant.

Interventions	**General details:** performed according to the standard protocols provided by the manufacturer; inserted using a percutaneous technique; regional anaesthesia; preoperative antibiotics; traction table; prophylactic antibiotics for 3 days; exercise from first POD; walking with weight-bearing as soon as possible; clinical follow-up at 3, 6, 9, and 12 months; surgical experience: "all operations were performed by expert surgeons who had equal levels of experience with both the PCCP and PFNA"

Gou 2013 *(Continued)*

	Intervention group 1 • PFNA (Synthes, USA); solid titanium nail with a length of 170 mm or 240 mm; cephalic fixation was performed with the helical blade; details of distal locking were not reported • Randomised = 45; no reported loses **Intervention group 2** • PCCP (Orthofix Orthopedics, Italy); a 125-mm plate, two dynamic neck screws (lengths: 90 mm to 140 mm); three shaft screws (lengths: 31 mm to 43 mm) • Randomised = 45; no reported loses
Outcomes	**Outcomes measured/reported by study authors:** operation time; intraoperative blood loss; perioperative blood loss; LOS; mortality; hip pain; OHS; HHS; mobility; cardiac failure; pneumonia; UTI; DVT; postoperative fracture; superficial infection; cerebral infarction; urosepsis; haematoma; fat embolism syndrome **Outcomes relevant to the review:** LOS; hip pain; functional status (OHS, 12 months); mobility (Parker 1993, 12 months); complications at 12 months: cardiac failure; pneumonia; UTI; DVT; postoperative fracture (femoral shaft fracture); superficial infection **Note:** data for functional status is reported using 2 measurement tools - OHS and HHS (with mean scores and categorical data for HHS). In analysis, we have used data for OHS.
Notes	**Funding/sponsor/declarations of interest:** funding not reported; authors state that no conflicts exist **Study dates:** January 2008 and October 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	Quote: "using a sealed-envelope system" Comment: study authors do not report if envelopes are opaque and sequentially-numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote: “All operations were performed by expert surgeons who had equal levels of experience with both the PCCP and PFNA”
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.

Gou 2013 *(Continued)*

Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Guerra 2014

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFN versus DHS
Participants	**Total number of randomised participants:** 31 **Inclusion criteria:** > 65 years old; intertrochanteric fracture of the femur (AO classification 31 A1 or 31 A2) **Exclusion criteria:** compound femoral fracture; contraindications to surgery; non-ambulatory before the presenting injury or presence of any other fractures **Setting:** single centre; orthopaedic hospital, Brazil **Baseline characteristics** **Intervention group 1** (PFN) • Age (mean (SD)): 80.17 (± 4.73) years • Gender (M/F): 1/11 • ASA status (I/II/III/IV): 0/5/5/2 **Intervention group 2** (DHS) • Age (mean (SD)): 77.89 (± 6.92) years • Gender (M/F): 5/14 • ASA status (I/II/III/IV): 0/9/9/1 **Note:** study authors did not report smoking history; medication; BMI; comorbidities; mobility; place of residence; cognitive status; or preoperative waiting time
Interventions	**General details:** clinical follow-up at 3, 6 and 12 months; experience of surgeon is not reported **Intervention group 1** • PFN; no further details • Randomised = 12; losses = 2 (death); analysed for mortality = 12; analysed for functional status at 3 months = 11; analysed for functional status at 12 months = 10 **Intervention group 2**

Guerra 2014 *(Continued)*

- DHS; no further details
- Randomised = 19; losses = 8 (death); analysed for mortality = 19; analysed for functional status at 3 months = 12; analysed for functional status at 12 months = 11

Outcomes	**Outcomes measured/reported by study authors:** FRS questionnaire (available at 3 months, 6 months, and 12 months); ASA status; mortality **Outcomes relevant to the review:** mortality (12 months); functional status (reported as FRS (Zuckerman 2000; score of 0 to 44; higher scores indicates better functional capacity; 3 and 12 months)
Notes	**Funding/sponsor/declarations of interest:** study authors declare that no funding was received and that they have no conflicts of interest **Study dates:** from October 2007; no end date

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Random selection from a box containing 20 envelopes. (10 DHS and 10 PFN)" Comment: envelopes replaced following selection
Allocation concealment (selection bias)	Unclear risk	The study authors do not report if envelopes are sealed, opaque and sequentially-numbered.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	The losses are explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Guyer 1991

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus DHS

Participants	**Total number of randomised participants:** 100
	
	Inclusion criteria: trochanteric and subtrochanteric proximal femoral fractures. Classification Evans modified by Jensen (stable and unstable)
	
	Exclusion criteria: not reported
	
	Setting: single centre; orthopaedic hospital, Switzerland
	
	Baseline characteristics (overall)
	
	• Age (mean): 80 years
	
	Baseline characteristics
	
	Intervention group 1 (Gamma nail)
	
	• Age (mean): 79.5 years
	• Gender (M/F): 9/41
	• Fracture classification (n)
	  ◦ Pertrochanteric (stable/unstable): 23/24
	  ◦ Intertrochanteric: 3
	
	Intervention group 2 (DHS)
	
	• Age (mean): 80.3 years
	• Gender (M/F): 6/44
	• Fracture classification (n)
	  ◦ Pertrochanteric (stable/unstable): 19/26
	  ◦ Intertrochanteric: 5
	
	Note: study authors report no baseline characteristics for smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, or ASA status

Interventions	**General details:** surgeons inexperienced with both devices; surgery within 24 hours; prophylactic antibiotics and low dose heparin; mobilisation as tolerated within 3 days of surgery **Intervention group 1** • Gamma intramedullary nail; cephalic fixation is performed with a single screw; nail length was not reported however it is highly probable that all nails were short nails; details regarding distal locking were not provided • Randomised = 50; losses = 22 (8 deaths, 14 lost to follow-up); analysed for mobility and pain = 28; analysed for all other outcomes = 50 **Intervention group 2** • DHS; no further implant or operative details were provided • Randomised = 50; losses = 18 (8 deaths, 10 lost to follow-up); analysed for mobility and pain = 32; analysed for all other outcomes = 50
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union; reoperation; deep wound infection; wound haematoma; LOS; shortening of leg (> 1 cm); mortality (available at 3 days, 30 days, and 3

Guyer 1991 *(Continued)*

	months); pain at follow-up (pain on walking); place of residence at 3 months; mobility (impaired walking and categorical data according to walking aids) **Outcomes relevant to the review:** mortality (3 months); unplanned return to theatre (3 months); mobility (categorical data: complete walking ability, < 1 aid, > 1 aid; at 3 months); pain (at 3 months); complications: intra- and postoperative fracture; cut-out; deep infection (all at 3 months)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** September 1989 to June 1990

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote (translation from German): "AO DHS and gamma nails were implanted alternatively."
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation using this method of randomisation.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeon performance. Surgeons, care personnel and participants were not blinded.
Other performance bias: surgeon experience of both implants	High risk	The study authors describe surgeons as inexperienced with the implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	Large number of participants lost to follow-up for pain and mobility data. Other losses are explained by death, and data for other outcomes are complete.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Han 2012

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma nail versus Proximal femoral locking plate
Participants	**Total number of randomised participants:** 83 **Inclusion criteria:** > 60 years of age; Jenson type II and above classification of fracture **Exclusion criteria:** ASA grade IV and V; unable to tolerate anaesthesia **Setting:** single centre; Orthopaedic Hospital; China **Baseline characteristics** **Intervention group 1** (intramedullary) • Age (range): 65 to 90 years • Gender (M/F): 24/17 • ASA status (range): 2 to 4 **Intervention group 2** (extramedullary) • Age (range): 64 to 92 years • Gender (M/F): 23/19 • ASA status (range): 2 to 4 **Note:** study authors did not report baseline characteristics for: smoking history, medication, BMI, co-morbidities, mobility assessment, place of residence; cognitive status, preoperative waiting times, or fracture classification
Interventions	**General details:** no mention of surgical experience **Intervention group 1** • Gamma nail; cephalic fixation is achieved with a single screw; length of the nails used was not reported nor were details about distal locking • Randomised = 41; no apparent losses; analysed for all outcomes = 41 **Intervention group 2** • Proximal femoral locking plate; there are 4 locking screw holes available for static cephalic fixation • Randomised = 42; no apparent losses; analysed for all outcomes = 42
Outcomes	**Outcomes measured/reported by study authors:** length of operation; intra-operative bleeding; haemoglobin reduction on POD 2; fracture healing - local pain and percussion pain as a marker of healing; fracture healing - radiographic parameters; functional recovery - Parker and Palmer mobility score **Outcomes relevant to the review:** mobility (using Parker 1993; at end of follow-up) **Note:** average follow-up time of 10.6 months (range 8 to 12)
Notes	**Funding/sponsor/declarations of interest:** unknown **Study dates:** June 2008 to June 2010

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**

Han 2012 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	According to the English abstract, participants were randomly divided into groups, but with no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Haq 2014

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFN versus reverse distal femoral locking plate
Participants	**Total number of randomised participants:** 40 **Inclusion criteria:** unstable intertrochanteric fracture with compromised lateral wall (AO 31A 2.2 to 3.3); surgery within 3 weeks **Exclusion criteria:** aged < 18 years; pathological fracture; multiple injuries; fractures with significant subtrochanteric extension (> 3 cm); unable or unwilling to give informed consent; unfit for surgical intervention **Setting:** single centre; University Hospital, India **Baseline characteristics** **Intervention group 1** (PFN) • Age (mean (SD)): 55.55 (± 17.09) years • Gender (M/F): 10/10 • ASA status (I/II/III/IV): 8/12/0/0 • Fracture classification (A 2.2 to 2.4/A 3.1 to 3.3): n = 9/11

Haq 2014 *(Continued)*

Intervention group 2 (distal femoral locking plate)

- Age (mean (SD)): 53.95 (± 14.75) years
- Gender (M/F): 18/2
- ASA status, (I/II/III/IV): 9/9/2/0
- Fracture classification (A 2.2 to 2.4/A 3.1 to 3.3): n = 12/8

Overall

- Age (mean): 54.7 years
- Gender (M/F): 28/12
- ASA status (I/II/III/IV): 17/21/2/0
- Fracture classification (A 2.2 to 2.4/A 3.1 to 3.3): n = 21/19

Notes

- Study authors did not report smoking history; medication; BMI; comorbidities; mobility; place of residence; cognitive status; or preoperative waiting time
- Difference in gender distribution was reported as statistically significant; no other categories produced a meaningful difference

Interventions	**General details:** weight-bearing as soon as possible; clinical follow-up at 2 and 6 weeks and 3, 6 and 12 months; surgical experience: "the surgeons doing the procedure were adequately trained in both the procedures and had been doing it regularly before the start of the trial" **Intervention group 1** • PFN (Green Surgicals, Gujarat, India); cephalic fixation was performed with two screws; length of nails used was not reported however it is highly probable that all nails were short nails; details regarding distal locking were not provided • Randomised = 20; losses (see note); analysed for function and mobility at 12 months = 17 **Intervention group 2** • Distal femoral locking compression plate (Green Surgicals, Gujarat, India); 4 to 6 proximal locking screws; 3 or 4 screws for distal fixation • Randomised = 20; losses (see note): analysed for function and mobility at 12 months = 17 **Notes** • We noted some discrepancies in the study report main text and tables. We used data in the text. • Reasons for loss to follow-up are not reported.
Outcomes	**Outcomes measured/reported by study authors:** duration of surgery; blood loss during surgery; fluoroscopy time; type of reduction; difficulty in reduction; surgeon's perception of surgery; position of implant; Parker Palmer mobility score; HHS (mean scores and categorical data); ADL: SF-12 (physical and mental component scores); revision surgery; non-union; malunion; shortening; length of follow-up: 1 year **Outcomes relevant to the review:** mobility (Parker Palmer mobility score, 12 months); functional status (mean HHS, 12 months); HRQoL (SF-12, 12 months); unplanned return to theatre (12 months); non-union **Note:** we did not included data for fixture failures and infection because these were not clearly reported.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** November 2011 and October 2012

Risk of bias

Haq 2014 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Use of a computer-generated randomisation table
Allocation concealment (selection bias)	Unclear risk	Quotes: “opaque envelope technique”. "The envelope was opened 24 hours before surgical intervention by the treating surgeon." Comment: study authors do not report if envelopes are sealed and sequentially-numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote: “The surgeons doing the procedure were adequately trained in both the procedures and had been doing it regularly before the start of the trial"
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	The losses were few and were balanced between groups.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Hardy 1998

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** IMHS versus SHS
Participants	**Total number of randomised participants:** 100 (see notes) **Inclusion criteria:** trochanteric proximal femoral fractures; classification according to Jensen: stable (types I & II) and unstable (types II, IV & V) **Exclusion criteria:** < 60 years of age; pathological fractures; incorrect anatomy; history of fracture or operation involving same limb; Paget's disease **Setting:** single centre; hospital; Belgium

Hardy 1998 *(Continued)*

	Baseline characteristics **Intervention group 1** (IMHS) • Age (mean (SD)): 81.7 (± 11.8) years • Gender (M/F): 8/42 • BMI (mean (SD)): 21.9 (± 6.2) kg/m2 • Comorbidities (type I/II/III (Fitts 1959)): n = 12/36/2 • Mobility assessment (group 1/2/3/4 (Jensen 1981)): n = 11/10/5/24; mobility score 5.2 (± 3.3) (Parker 1993) • Place of residence (home/nursing home): n = 26/24 • Cognitive status (mental score (Qureshi 1974)): 6.1 (± 4.1) • ASA status (I/II/III/IV/V): n = 5/12/23/10/0 • Fracture classification (stable/unstable): n = 13/37 **Intervention group 2** (SHS) • Age (mean (SD)): 79.5 (± 10.7) years • Gender (M/F): 15/35 • BMI (mean (SD)): 23.4 (± 7.1) kg/m2 • Comorbidities (type I/II/III (Fitts 1959)): n = 14/30/6 • Mobility assessment (group 1/2/3/4 (Jensen 1981)): n = 10/7/7/26; mobility score 4.4 (± 2.9) (Parker 1993) • Place of residence (home/nursing home): n = 24/26 • Cognitive status (mental score (Qureshi 1974)): 5.4 (± 4.1) • ASA status (I/II/III/IV/V): n = 5/13/18/13/1 • Fracture classification (stable/unstable): n = 16/34 **Note:** baseline data not described for: smoking history, medication or comorbidities
Interventions	**General details:** spinal or general anaesthesia; weight-bearing on POD 4; clinical assessment at 1, 6 and 12 months; surgeon experience - for IMHS, study report refers to prolonged learning curve required for insertion and SHS is routine; 2 senior operating surgeons, 3 junior attending surgeons **Intervention group 1** • IMHS (Smith & Nephew), in all cases a short nail was used (21 cm long). Nail diameters were 12/14/16 mm (n = 36/12/2). Distal locking with 2 screws/1 screw/no screws (n = 28/18/4) • Randomised = 50; losses = 15 (death); analysed for mobility at 12 months = 35; analysed for all other outcomes = 35 **Intervention group 2** • SHS (Oseto hip screw, Switzerland); 135 degree barrel • Randomised = 50; losses = 15 (death); analysed for mobility at 12 months = 35; analysed for all other outcomes = 35
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; transfusion; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union; reoperation; wound infection; wound haematoma; pneumonia; thromboembolic complications (DVT, PE); UTI; leg shortening; mortality; mid-thigh pain; hip pain at follow-up; mobility (available at 1, 3, 6, and 12 months); social function; length of follow-up: 1 year (see notes) **Outcomes relevant to the review:** mortality (during hospital stay; 12 months); mobility (12 months; Parker 1993 scale); complications: deep infection; fracture during surgery; postoperative fracture; cut-out; non-union; pneumonia/chest infection; cardiac failure; DVT; UTI; PE; unplanned return to theatre (all at 12 months) **Note:** we did not report mobility data at 3 months because denominators were not clearly reported

Hardy 1998 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** funding received from Smith & Nephew Richards **Study dates:** December 1993 to January 1995 **Note:** since a full report of the trial was published in 1998, a conference abstract presenting the results of 160 participants at 18 months became available (Hardy 1999). We have not included the data from Hardy 1999 because these data require further clarification.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "prospectively randomised according into two treatment groups according to the medical record number"
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation with this method of randomisation.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Quote: "The different levels of experience of the ...operating surgeons and ... attending surgeons ..and the prolonged learning curve for insertion of intramedullary hip-screws may have also affected the operative time."
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	All losses were explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Harrington 2002

Study characteristics

Methods	RCT; parallel design

Harrington 2002 *(Continued)*

Review comparison group: IMHS versus SHS

Participants	**Total number of randomised participants:** 102
	
	Inclusion criteria: unstable trochanteric proximal femoral fractures; > 65 years of age; Evans classification III, IV and V.
	
	Exclusion criteria: pathological fractures; previous fracture; other fracture; dementia meaning inability to consent
	
	Setting: single centre; orthopaedic hospital, UK
	
	Baseline characteristics
	
	Intervention group 1 (IMHS)
	
	• Age (mean (SD)): 83.8 (± 8.5) years
	• Gender (M/F): 10/40
	• Mobility assessment (n)
	  ◦ Non-ambulator: 6
	  ◦ Household ambulator: 8
	  ◦ Community ambulator (with aid): 21
	  ◦ Independent: 15
	• ASA status (I/II/III/IV): 3/22/16/9
	• Fracture classification (type III/IV/V (Evans 1949)): n = 13/11/26
	
	Intervention group 2 (specify by name)
	
	• Age (mean (SD)): 82.1 (± 8.6) years
	• Gender (M/F): 11/41
	• Mobility assessment (n)
	  ◦ Non-ambulator: 10
	  ◦ Household ambulator: 6
	  ◦ Community ambulator (with aid): 26
	  ◦ Independent: 10
	• ASA status (I/II/III/IV/): 4/20/17/11
	• Fracture classification (type III/IV/V (Evans 1949)): n = 15/10/27
	
	Note: baseline data not described for: smoking history, medication, comorbidities, mobility, place of residence, cognitive status or ASA status

Interventions	**General details:** no details on prophylaxis or rehabilitation programme; clinical follow-up at 3, 6 and 12 months by observers blind to procedure; surgeons familiarised themselves with the IMHS prior to the study, but experience was not balanced between both implants **Intervention group 1** • IMHS (Smith & Nephew Richards); short nails used in all cases were 21 cm long. Nail diameter was 12 mm in all cases. Distal locking was performed with 2 screws in all cases. • Randomised = 50; no reported losses **Intervention group 2** • SHS (Smith & Nephew) • Randomised = 52; no reported losses
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; radiographic screening time; transfusion requirements; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union of fracture; other fracture healing complications; LOS; mortality; patient mobility; regain of pre-fracture living status; length of follow-up: 12 months

Harrington 2002 *(Continued)*

	Outcomes relevant to the review: mortality (during hospital stay and at 6 months); complications (12 months): intraoperative fracture; postoperative fracture; cut out; non-union; blood transfusion
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported **Note:** we received additional information from study authors.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	Quote: "randomised on admission using a sealed envelope method". Comment: study authors do not report if envelopes are opaque and sequentially-numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Quote: "Participating surgeons were required to familiarise themselves with the intramedullary implant and its insertion in supervised bone model sessions prior to using it in the clinical setting" Comment: we considered this insufficient for the purposes of the trial.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were because of death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Haynes 1996

Study characteristics

Methods	RCT; parallel design

Haynes 1996 *(Continued)*

Review comparison group: Gamma intramedullary nail versus DHS

Participants	**Total number of randomised participants:** 50 **Inclusion criteria:** trochanteric or 'high' subtrochanteric proximal femoral fractures **Exclusion criteria:** previous non-consolidated femur fracture **Setting:** single centre; orthopaedic hospital, UK **Baseline characteristics (overall)** • Age (mean): 80 years • Gender (M/F): 14/36 **Baseline characteristics** **Intervention group 1** (Gamma nail) • Cognitive status (mental ability (Qureshi 1974)): mean = 8.7 • Preoperative waiting time (mean): 1.8 days • Fracture classification (stable/unstable): n = 4/13; high subtrochanteric (unstable): n = 2 **Intervention group 2** (DHS) • Cognitive status (mental ability (Qureshi 1974)): mean = 7.1 • Preoperative waiting time (mean): 2.4 days • Fracture classification (stable/unstable): n = 10/21 **Notes** • Baseline data not described for: smoking history, medication, comorbidities, mobility, place of residence, cognitive status or ASA status • Age and gender not reported by group
Interventions	**General details:** manufacturers recommended procedures; mobilised as quickly as possible. For experience of surgeon: DHS commonly used but a minimum of 5 Gamma nails were used by each surgeon before any cases were included in the trial (also see note about unfamiliarity of the surgeons as a reason for exclusion) **Intervention group 1** • Gamma intramedullary nail (Howmedica); distal locking was performed at the discretion of the operating surgeon; nail length was not reported however it is highly probable that all nails used in the study were short nails • Randomised = 19; losses = 1 (death); analysed for mobility = 18; analysed for all other outcomes = 19 **Intervention group 2** • DHS • Randomised = 31; losses = 8 (death); analysed for mobility = 23; analysed for all other outcomes = 31 **Note:** fewer participants in the Gamma nail group because surgeons were more likely to drop these patients from the trial because of unfamiliarity with the Gamma nail
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; operative fracture of femur; cut-out; non-union; reoperation; wound infection; pneumonia; pressure sore; wound haematoma; DVT; PE; LOS; shortening of leg; mortality; pain at follow-up; place of residence (6 months after surgery); impaired walking **Outcomes relevant to the review:** mortality (6 months); LOS; mobility (categorical: independent; aided; bed bound; at 6 months); discharge destination (return to own home); cut-out; unplanned return to theatre

Haynes 1996 *(Continued)*

Notes

- We noted that outcomes were listed as measured, but data for these are not included in the study report: operative fracture of femur, non-union, wound infection, pneumonia, pressure sore, wound haematoma, DVT, PE, leg shortening
- Study authors reported data for LOS without SD and we did not include these data in meta-analysis; we reported these data in an appendix

Notes	**Funding/sponsor/declarations of interest:** sponsored and part administered by Howmedica **Study dates:** not reported **Note:** we noted that the study report was part of a PhD research project.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Use of "randomisation cards". However, the imbalance in numbers was explained by unfamiliarity of surgeons with Gamma nail treatment. Quote: "This resulted in a temptation to omit the patient from the trial if a Gamma nail was drawn as treatment, from the randomisation cards".
Allocation concealment (selection bias)	Low risk	We presumed from the information regarding selection of participants, that allocation on the randomisation cards was adequately concealed, with decisions made by surgeons after selection of a card.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Surgical procedures were as recommended by the implant manufacturers, and "A minimum of 5 Gamma nails were then inserted by each surgeon before any cases were included in the trial". Comment: SHS was used routinely. However, mention of unfamiliarity of the surgeons (various) with the treatment was a putative reason for post-randomisation exclusion and we therefore assumed that not all surgeons were sufficiently experienced with the Gamma nails
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	All losses were explained by death, which is expected in this population.

Haynes 1996 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Hoffman 1996

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus SHS (AMBI hip screw)

Participants	**Total number of randomised participants:** 69 (2 died prior to surgery and were not reported in the numbers randomised to each group)
	
	Inclusion criteria: trochanteric proximal femoral fractures. Jensen types 1 to 5; stable and unstable based on Evans; > 50 years of age
	
	Exclusion criteria: pathological fractures
	
	Setting: single centre; orthopaedic hospital, New Zealand
	
	Baseline characteristics (overall)
	
	• Age (mean (range)): 81 years
	• Gender (M/F): 16/53
	
	Baseline characteristics
	
	Intervention group 1 (Gamma nails)
	
	• Age (mean (SD)): 83.2 (± 8.1) years
	• Gender (M/F): 4/27
	• ASA status (I/II/III/IV/V): 0/10/15/5/1
	• Preoperative waiting time (mean (SD)): 1.6 (± 1.1) days
	• Fracture classification (Type 1/2/3/4/5 (Jensen 1981)): n = 2/8/12/2/7; stable: n = 10; unstable: n = 21
	• Additional information
	  ○ Osteoporosis (Singh index 3/4/5/6 (Singh 1970)): n = 3/2/9/15
	
	Intervention group 2 (SHS)
	
	• Age (mean (SD)): 79 (± 10.4) years
	• Gender (M/F): 12/24
	• ASA status (I/II/III/IV/V): 0/18/15/3/0
	• Preoperative waiting time (mean (SD)): 1.9 (± 1.4) days
	• Fracture classification (Type 1/2/3/4/5 (Jensen 1981)): n = 2/10/11/4/9; stable: n = 12; unstable: n = 24
	• Additional information
	  ○ Osteoporosis (Singh index 3/4/5/6 (Singh 1970)): n = 2/1/12/16
	
	Note: baseline data not described for: smoking history, medication, comorbidities, mobility, place of residence, cognitive status or ASA status

Interventions	**General details:** prophylactic antibiotics; general anaesthesia (50 participants), spinal anaesthesia (17 participants); closed reduction; image intensifier; manufacturers guidelines followed for each device; mobilised with weight bearing as soon as possible; clinical assessment at 6 and 12 weeks and 6

Hoffman 1996 *(Continued)*

	months; surgeons did not have comparable experience with implants (longer learning curve with Gamma nail than with SHS; 4 orthopaedic trainees, normal supervision) **Intervention group 1** • Gamma intramedullary nail (Howmedica); protocol for distal locking changed during the study - the first 5 cases were all locked, thereafter only unstable fracture configurations were locked; study report does not specify the length of nails used however it is highly probable that all nails were short nails • Randomised = 31; losses not reported **Intervention group 2** • SHS (AMBI) (Smith & Nephew) • Randomised = 36; losses not reported **Note:** 2 participants died before surgery.
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; radiographic screening time; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union (time to union); reoperation; wound infection; pneumonia; pressure sores; DVT; any medical complication; LOS; shortening of leg; mortality; pain at follow-up (unresolved pain in patients with intertrochanteric fractures); non return to previous residence; patient mobility; length of follow-up: 6 months **Outcomes relevant to the review:** discharge destination; LOS; mortality (in hospital and during follow-up); unplanned return to theatre; complications (6 months): intraoperative fracture; postoperative fracture; cut-out; deep infection; UTI; CVA; MI; pneumonia; DVT **Notes** • Study authors do not clearly report data for mobility. • We did not include data for pain (reported as number with resolved pain at 2, 6, 12, and 26 weeks) because the number of participants per group was not reported.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "computer-generated blocked randomization"
Allocation concealment (selection bias)	Low risk	Quote: "The treatment selections ... were sealed into opaque numbered envelopes that also contained a stiff card to further prevent disclosure of allocation."
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Quotes: most operations carried out by "one of four orthopaedic trainees ... supervised as appropriate.." and "longer learning curve for the Gamma nail may be the reason for the differences noted."
Blinding of outcome assessment (detection bias)	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.

Hoffman 1996 *(Continued)*

Clinically-assessed subjective outcomes		
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	All losses explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Hoffmann 1999

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IMHS versus SHS

Participants	**Total number of randomised participants:** 110
	
	Inclusion criteria: pertrochanteric proximal femoral fractures. Classification based on Evans-Jensen: all 5 categories: stable and unstable fractures. Also AO 31 A1, A2 and A3 (just 2 fractures)
	
	Exclusion criteria: pathological fractures, old fractures, bedridden patients, polytrauma
	
	Setting: single centre; orthopaedic hospital, Germany
	
	Baseline characteristics
	
	Intervention group 1 (intramedullary)
	
	• Age (median): 82 years
	• Gender (M/F): 10/46
	• Comorbidities (n)
	  ◦ None: 3
	  ◦ Respiratory/pulmonary: 4
	  ◦ Cardiovascular: 21
	  ◦ Gastrointestinal: 22
	  ◦ Urogenital: 22
	  ◦ Diabetes mellitus: 23
	  ◦ Obesity: 24
	  ◦ Other: 26
	• Fracture classification (stable/unstable): n = 20/36
	  ◦ 31 A1: 19
	  ◦ 31 A2: 35
	  ◦ 31 A3: 2
	
	Intervention group 2 (extramedullary)
	
	• Age (median): 81 years

Hoffmann 1999 *(Continued)*

- Gender (M/F): 12/42
- Comorbidities (n)
  - None: 12
  - Respiratory/pulmonary: 13
  - Cardiovascular: 20
  - Gastrointestinal: 20
  - Urogenital: 20
  - Diabetes mellitus: 20
  - Obesity: 20
  - Other: 20
- Fracture classification (stable/unstable): n = 20/34
  - 31 A1: 22
  - 31 A2: 32
  - 31 A3: 0

Note: study authors report no baseline characteristics for: smoking history, medication, BMI, mobility assessment, place of residence, cognitive status or ASA status

Interventions	**General details:** surgeons were not experienced (operations by junior and senior staff); surgery within 24 hours of admission; prophylactic antibiotics; postoperative thromboembolics with heparin **Intervention group 1** • IMHS (Smith & Nephew); nail length 210 mm; nail diameter 12 mm; cephalic fixation was with a single screw; distal locking was performed at the discretion of the operating surgeon • Randomised = 56 **Intervention group 2** • DHS • Randomised = 54
Outcomes	**Outcomes measured/reported by study authors:** length of anaesthesia; length of surgery; operative blood loss; difference in haemoglobin; radiographic screening time; operative fracture of the femur; later fracture of the femur; loss of fracture reduction requiring reoperation; reoperation; wound infection; deep wound infection; wound haematoma; thromboembolic complication; clinical complications; LOS (acute); shortening of leg (> 1 cm); rotational deformity ('relevant'); mortality; pain (on walking); return to pre-fracture residential status; impaired walking; Merle d'Aubigne hip score; length of follow-up: mean 3.7 months **Outcomes relevant to the review:** delirium; mortality (3 to 4 months); unplanned return to theatre; pain (on walking; at 3 to 4 months); discharge destination (return to previous residence); intra- and postoperative fracture; deep infection; chest infection/pneumonia; DVT; mobility (categorical: unaided, with 1 aid, with more than 1 aid); functional status (using Merle d'Aubigne categories: excellent, good, moderate; at 3 to 4 months) **Note:** data for pain were reported as number of people experiencing pain, as well as the number of people that were pain free. We included data only for those experiencing pain.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** 1994 to 1996 **Note:** study reported in German; we obtained only a limited translation

Risk of bias

Bias	Authors' judgement	Support for judgement

Hoffmann 1999 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes, but no additional details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeon performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Involved both senior and junior surgeons - tendency for more senior surgeons for the nail operations, and we could not be certain whether experience in both devices was equivalent
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses explained by death, which is expected in this population
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Hong 2011

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFN versus DHS
Participants	**Total number of randomised participants:** 20 **Inclusion criteria:** > 60 years of age; intertrochanteric fracture; AO classification A1 or A2; surgery within 2 weeks of fracture; no prior disease that could affect serum markers **Exclusion criteria:** pathologic fracture; multi trauma or open fractures; drug or alcohol abuse; non-ambulatory status; surgery beyond 2 weeks after trauma **Setting:** single centre; hospital; South Korea

Hong 2011 *(Continued)*

	Baseline characteristics **Intervention group 1** (PFN) • Age (mean (SD)): 76.5 (± 5.4) years • Gender (M/F): 6/4 • BMI (mean): 26.9 (± 4) kg/m^2 **Intervention group 2** (DHS) • Age (mean (SD)): 81.1 (± 5.3) years • Gender (M/F): 5/5 • BMI (mean (SD)): 25.7 (± 4.6) kg/m^2 **Overall** • Gender (M/F): 11/9 • BMI (mean): 26.3 kg/m2 **Note: b**aseline data not described for: smoking history, medication, comorbidities, mobility, place of residence, cognitive status or ASA status
Interventions	**General details:** single surgeon; fracture reduction; fluoroscopic guidance; clinical follow-up at 6 months **Intervention group 1** • PFN; femur was reamed using a 17-mm reamer; cephalic blade was inserted; a distal static locking screw was used in all cases • Randomised = 10; no losses reported; analysed for non-union = 10 **Intervention group 2** • DHS; 3-hole plate • Randomised = 10; no losses reported; analysed for non-union = 10 **Note:** study authors do not report skills and experience of surgeon, type of anaesthesia, prophylactic use of antibiotics or antithromboembolics, postoperative mobilisation or weight-bearing
Outcomes	**Outcomes measured/reported by study authors:** pre- and postoperative bone healing status; data related to complications; incision length; operation time (skin to skin); estimated blood loss; blood samples at screening and on the morning before surgery for creatinine kinase, c reactive protein and serum myoglobin; blood samples taken postoperatively in the recovery room and at 8, 16, 24, 36, 48 and 72 hours postoperatively; haemoglobin and haematocrit measured preoperatively and at 16, 36 and 72 hours postoperatively; cardiac troponin I levels taken on the morning before surgery and 16 hours postoperatively **Outcomes relevant to the review:** intra- and postoperative fractures; cut-out (at 6 months)
Notes	**Funding/sponsor/declarations of interest:** authors state that no funding was received and no conflicts exist **Study dates:** May 2009 to October 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Use of computer-generated randomisation

Hong 2011 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Single surgeon preformed all operations, but it is not clear whether this surgeon was equally experienced with both implants at the start of the trial.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Kouvidis 2012

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Endovis nail ("dual lag screw cephalomedullary nail") versus DHS
Participants	**Total number of randomised participants:** 165 **Inclusion criteria:** low-energy intertrochanteric fractures (AO type 31-A) **Exclusion criteria:** < 65 years of age; multi-trauma patients; patients with previous ipsilateral hip or femur surgery possibly affecting functional outcome; patients with pathological fractures **Setting:** single setting; orthopaedic ward in hospital, Greece **Baseline characteristics** **Intervention group 1** (cephalomedullary nail) • Age (mean (SD)): 81.95 (± 7.21) years • Gender (M/F): 18/72 • ASA status (I or II/III or IV): n = 31/55 • Preoperative waiting time (mean (SD)): 3.24 (± 2.44) hours • Fracture classification (stable (A1)/unstable (A2 or A3)): n = 26/60 • Additional information: ○ FRS (mean (SD)): 85.43 (± 16.69) **Intervention group 2** (SHS)

Kouvidis 2012 *(Continued)*

- Age (mean (SD)): 82.53 (± 6.79) years
- Gender (M/F): 26/49
- ASA status (I or II/III or IV): 27/52
- Preoperative waiting time (mean (SD)): 3.18 (± 2.46) hours
- Fracture classification (stable (A1)/unstable (A2 or A3)): n = 21/58
- Additional information
  - FRS (mean (SD)): 84.05 (± 15.25)

Note: baseline data not described for: smoking history, medication, BMI, comorbidities, mobility, place of residence, cognitive status or ASA status

Interventions	**General details:** fracture table; spinal anaesthesia; closed reduction; use of an image intensifier; small lateral approach; standard postoperative protocol; immediate passive exercises; weight bearing encourage on second day; clinical examinations at 3 weeks and 4 months. Surgical experience: most operations were carried out by orthopaedic residents under a senior surgeon's assistance. Residents had almost equal experience with both implants. **Intervention group 1** • Endovis Cephalomedullary nail ("dual lag screw cephalomedullary nail"); cervico-diaphyseal angle of 130 degree, a metaphyseal angle of 5 degrees; the nail is only made in one length measuring 195 mm; 2 holes for insertion of dynamic cephalic screws and 1 for a distal locking screw was utilised in all cases • Randomised = 86; analysed for functional status at 12 months = 62 (19 died, 5 lost) **Intervention group 2** • SHS; either the keyed (CLASSIC) or key-less (AMBI) systems in angles 130 to 140 degree with 2 to 4 slots (Smith & Nephew) • Randomised = 79; analysed for functional status at 12 months = 60 (12 died, 3 lost)
Outcomes	**Outcomes measured/reported by study authors:** FRS; mortality; length of surgery; LOS; duration of fluoroscopy; number receiving blood transfusion; later fracture of the femur; cut-out of implant; implant breakage; non-union; reoperation; wound infection; implant related complications (non-union, cut-out); LOS; tip-apex distance to assess position of implants; patient mobility (90% recovery or bedbound or wheelchair dependent); length of follow-up: 12 months **Outcomes relevant to the review:** mortality (12 months); LOS; unplanned return to theatre (12 months); cut-out; intraoperative and postoperative fracture; superficial infection; non-union; cut-out; blood transfusion; FRS (4 and 12 months); mobility (not achieving independent ambulation: bedridden or wheelchair) **Note:** although the text states that follow-up was at 36 months, we have reported follow-up as 12 months because this is the time line described in study report tables and the flow diagram.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** January 2005 to December 2006

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes, but study authors do not reported if envelopes are opaque and sequentially-numbered

Kouvidis 2012 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote: "vast majority of operations in our study were performed by orthopaedic residents under a senior surgeon's experience. The participating residents had almost equal experience in both implants. The senior surgeons had already performed more than fifteen Endovis procedures each prior to this study"
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses were explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Kukla 1997

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma nail versus DHS
Participants	**Total number of randomised participants:** 120 **Inclusion criteria:** > 60 years old; unilateral fracture (AO/ASIF 31-A1.1 to A3.3); ambulatory prior to trauma **Exclusion criteria:** pathological fractures; multiple injury patients **Setting:** single setting; orthopaedic hospital, Austria **Baseline characteristics (overall)** • Age (mean (range)): 83 (60 to 99) years • Gender (M/F): 18/102 • Mobility assessment (ambulate without aid/crutch or cane/2 elbow crutches/frame): n = 59/21/7/2

Kukla 1997 *(Continued)*

- Fracture classification (A1.1-1.3/A2.1-2.3/A3.1-3.3): n = 54/62/4

Baseline characteristics

Intervention group 1 (Gamma nail)

- Age (mean (SD)): 83 (± 9.1) years
- Gender (M/F): 14/46
- Mobility assessment (ambulate without aid/crutch or cane/2 elbow crutches/frame): n = 29/10/5/1
- Preoperative waiting time: within 24 hours, whenever possible
- Fracture classification (A1.1-1.3/A2.1-2.3/A3.1-3.3): n = 31/28/1

Intervention group 2 (DHS)

- Age (mean (SD)): 84 (± 8.3) years
- Gender (M/F): 4/56
- Mobility assessment (ambulate without aid/crutch or cane/2 elbow crutches/frame): n = 30/11/2/1
- Preoperative waiting time: within 24 hours, whenever possible
- Fracture classification (A1.1-1.3/A2.1-2.3/A3.1-3.3): n = 23/34/3

Note: baseline data not described for: smoking history, medication, BMI, comorbidities, mobility, place of residence, cognitive status or ASA status

Interventions	**General details:** spinal or general anaesthesia; clinical follow up at 6 months. Senior surgeons experienced in both operations **Intervention group 1** • Gamma intramedullary nail (Howmedica, Germany); although the authors did not specify the length of nail used, from the text it can be inferred that short nails were likely used in all cases, no surgical details reported • Randomised = 60 **Intervention group 2** • DHS (Rob Mathys, Switzerland); no surgical details reported • Randomised = 60
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union; re-operation; wound infection; deep wound infection; wound haematoma; pneumonia; DVT; PE; any medical complication; LOS; shortening of leg (> 2 cm); mortality; non-return to previous residence; impaired walking; length of follow-up: 6 months **Outcomes relevant to the review:** mortality (in hospital, and 6 months); LOS; mobility; complications (6 months): deep infection, non-union, intraoperative fracture, cut-out, postoperative fracture, plate/screw failure (reported as hardware failure), pneumonia, DVT, PE; unplanned return to theatre **Note:** we inverted data from study authors for 'impaired walking' and included this in the review outcome for 'independent mobility'
Notes	**Funding/sponsor/declarations of interest:** authors do not report funding or conflicts of interest **Study dates:** August 1993 to March 1994 **Note:** we received additional information from the study authors which included a draft report prior to publication

Risk of bias

Bias	Authors' judgement	Support for judgement

Kukla 1997 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Quote (from direct communication with study authors): "random permutation" Comment: insufficient information
Allocation concealment (selection bias)	Unclear risk	Quote: "Allocation to the 2 groups was achieved by randomized, sealed envelopes" Comment: study authors do not report whether envelopes are opaque and sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Comment: "Senior surgeons who, having operated on at least 80 cases each, were experienced in the use of both devices."
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few losses which we did not expect to influence data
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Kuwabara 1998

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus CHS
Participants	**Total number of randomised participants:** 43 **Inclusion criteria:** trochanteric proximal femoral fractures. Evans classification: stable, unstable and 'type 2' (1 fracture)

Kuwabara 1998 *(Continued)*

Exclusion criteria: < 65 years of age

Setting: single centre; orthopaedic hospital, Japan

Baseline characteristics

Intervention group 1 (Gamma nail)

- Age (mean (SD)): 82.8 (± 7.1) years
- Gender (M/F): 5/15
- Fracture classification (stable/unstable (Evans 1949)): n = 15/5

Intervention group 2 (CHS)

- Age (mean (SD)): 80 (± 6) years
- Gender (M/F): 7/16
- Fracture classification (stable/unstable (Evans 1949)): n = 15/7; type 2: n = 1

Note: baseline data not described for: smoking history, medication, BMI, comorbidities, mobility, place of residence, cognitive status, ASA status or preoperative waiting time

Interventions	**General details:** level of surgical experience is unknown **Intervention group 1** • Gamma intramedullary nail; no further surgical or implant details provided • Randomised = 20 **Intervention group 2** • CHS; no further surgical or implant details provided • Randomised = 23
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; operative fracture of the femur; later fracture of the femur; cut-out of implant; wound infection; inversion deformity; inversion deformity; loss in mobility and use of walking aids; length of follow-up: mean 6 months (5.7 and 6.5 months respectively for the two groups) **Outcomes relevant to the review:** mobility (categorical: able to walk; walk with a stick; walk with a support; standing with a support but unable to walk; wheelchair; bedridden; at 6 month follow up); intraoperative fracture; postoperative fracture; cut-out; superficial infection **Note:** type of infection is not defined. We have included these data with 'superficial infection' data.
Notes	**Funding/sponsor/declarations of interest:** no details of funding or conflicts being reported **Study dates:** not reported **Note:** study report published in Japanese. We obtained only a limited translation.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomised, but no additional details
Allocation concealment (selection bias)	Unclear risk	No details

Kuwabara 1998 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses reported
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Leung 1992

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus DHS
Participants	**Total number of randomised participants:** 225 patients; 226 fractures **Inclusion criteria:** peritrochanteric proximal femoral fractures; classified as "pertrochanteric or intertrochanteric with or without subtrochanteric extension" **Exclusion criteria:** < 65 years of age; purely subtrochanteric fractures **Setting:** single centre; orthopaedic hospitals, Hong Kong **Baseline characteristics (only for survivors)** **Intervention group 1** (Gamma nail) • Age (mean (SD)): 80.86 (± 8.41) years • Gender (M/F): 25/68 • Mobility assessment (independent/aided/bed bound): n = 58/34/1 • Place of residence (home/institution): n = 74/19 • ASA status (I/II/III/IV): 15/47/23/8 • Fracture classification (stable/unstable (Evans 1949)): n = 30/63

Leung 1992 *(Continued)*

	Intervention group 2 (DHS) • Age (mean (SD)): 78.27 (± 9.46) years • Gender (M/F): 30/63 • Mobility assessment (independent/aided/bed bound): n = 44/44/5 • Place of residence (home/institution): n = 64/29 • ASA status (I/II/III/IV): 10/42/38/3 • Fracture classification (stable/unstable (Evans 1949)): n = 20/73 **Note:** study authors did not report: smoking history, medication, BMI or waiting time for surgery
Interventions	**General details:** prophylactic antibiotics; general or spinal anaesthetic; traction table for closed reduction under fluroscopic control; immediate mobilisation with full weight-bearing; clinical follow-up at 6 weeks and 3 and 6 months. Most of the Gamma nail operations were performed by 1 senior surgeon with a special interest in intramedullary nailing, whilst the SHS operations were performed by a number of less experienced surgeons (from email communication with study authors) **Intervention group 1** • Gamma intramedullary nail (Howmedica International, Staines, Middlesex, England); distal locking was performed according to the discretion of the operating surgeon; although the authors did not specifically report the length of the nails used it can be inferred from the manuscript that all nails were likely short • Randomised = 113; followed up at 7.5 months = 93 for LOS, mobility, pain **Intervention group 2** • DHS; no further surgical or implant details were provided • Randomised = 113; followed up at 6.8 months = 93 **Note:** overall, 12 participants died within 4 weeks; 28 participants died within 6 months; 185 participants with 186 fractures at 12 months
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; radiographic screening time; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union (fracture healing); reoperation; deep wound infection; chest infection/pneumonia; any medical complication; LOS (mixed location); external rotational deformity; shortening of leg (> 2 cm); varus displacement (> 10 degrees); mortality; pain at follow-up (pain in hip and pain in thigh); impaired walking; length of follow-up: mean 7 months **Outcomes relevant to the review:** mortality (6 months); LOS; mobility (independent/aided/bed bound at 6 months); pain (reporting pain in hip at 6 months); complications (at 6 months): infection, cut-out, non-union, postoperative fracture; unplanned return to theatre (at 6 months) **Note:** study authors reported pain in the hip and the thigh region. In analysis, we included only data for hip pain.
Notes	**Funding/sponsor/declarations of interest:** quote: " No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article" **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "fixation was randomly assigned according to the sequence of admission"

Leung 1992 *(Continued)*

Allocation concealment (selection bias)	High risk	It was not possible to conceal allocation because of the method of randomisation.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Most of the Gamma nail operations were performed by one senior surgeon with a special interest in intramedullary nailing, whilst the SHD operations were performed by a number of less experienced surgeons.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Li 2018

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: PFNA versus DHS
Participants	**Total number of randomised participants:** 80 **Inclusion criteria:** elderly people ≥ 60 years of age, with osteoporosis, with femoral intertrochanteric fractures **Exclusion criteria:** people with bone or joint motor system diseases, diabetes mellitus, severe cardiorespiratory, hepatic, or renal dysfunctions, mental disorders, coagulation disorders, systemic malignant tumours, malignant tumour cachexia, or contraindications after intra-spinal anaesthesia puncture; using analgesia devices or drugs after the operation; declined to consent to enrolment **Setting:** single centre, hospital; China **Baseline characteristics**

Li 2018 *(Continued)*

	Intervention group 1 (intramedullary) • Age (mean (SD)): 75.6 (± 2.5) years • Gender (M/F): 20/20 • Fracture classification (Evans I/II/III/IV): n = 4/10/16/10 **Intervention group 2** (extramedullary) • Age (mean (SD)): 75.5 (± 2.6) years • Gender (M/F): 21/19 • Fracture classification (Evans I/II/III/IV): n = 3/12/15/10 **Note:** study authors report no baseline data for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, ASA status or preoperative waiting times
Interventions	**General details:** spinal epidural anaesthesia; wound drain for all cases **Intervention group 1** • PFNA; no further implant details are provided • Randomised = 40; losses = 0; analysed for all outcomes = 40 **Intervention group 2** • DHS helical blade; no further implant details are provided • Randomised = 40; losses = 0; analysed for all outcomes = 40 **Note:** study authors report no surgical details for: number of surgeons (and their skills and experience); or prepostoperative care (e.g. use of prophylactic antibiotics or antithromboembolics) or rehabilitation (e.g. time to mobilisation or weightbearing
Outcomes	**Outcomes measured/reported by study authors:** operation duration, blood loss, postoperative drainage volume, HHS, pain, bone mineral density and calcitonin level, 10-metre walking speed, 5-fold-sit-to-stand test time, fracture healing and weight bearing time, complications (cosa vara, loose nail, bone non-union, delayed union of fracture, femoral head necrosis and DVT) **Outcomes relevant to the review:** functional status (HHS); pain (VAS score; 0 = no pain, 10 = severe pain); complications (non-union, loosening and DVT); mobility (10m walking speed: average time of 3 trials (m/s)) **Note:** 18-month follow-up through outpatient, door-to-door, and telephone follow-up
Notes	**Funding/sponsor/declarations of interest:** funding not reported. The study authors declared no conflicts of interest. **Study dates:** January 2013 to December 2014

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Use of random number method
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.

Li 2018 *(Continued)*

Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	We noted some discrepancies reported in the tables. However, we have assumed there are no losses.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Little 2008

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** long Holland intramedullary nail versus CHS
Participants	**Total number of randomised participants:** 190 **Inclusion criteria:** low-energy extracapsular intertrochanteric fracture; classification AO/ASIF A1, A2 and A3 (stable and unstable fractures) **Exclusion criteria:** patients with subtrochanteric fractures **Setting:** single centre; orthopaedic hospital, United Kingdom **Baseline characteristics** **Intervention group 1** (Holland nail) • Age (mean (range)): 82.6 (54 to 102) years • Gender (M/F): 8/84 • Mobility assessment (Parker and Palmer score, mean (SD)): 6.5 (± 2.7) • Cognitive status (mini mental test score, mean (SD)): 8.1 (± 2.8) • ASA status (I/II/III/IV): 2/57/33/0 • Fracture classification (A1/A2/A3): n = 15/38/39 **Intervention group 2** (DHS) • Age (mean (range)): 84.2 (50 to 98) years • Gender (M/F): 20/78 • Mobility assessment (Parker and Palmer score, mean (SD)): 5.8 (± 2.8)

Little 2008 *(Continued)*

- Cognitive status (mini mental test score, mean (SD)): 7.5 (± 2.7)
- ASA status (I/II/III/IV): 3/55/37/3
- Fracture classification (A1/A2/A3): n = 29/51/18

Overall

- Age (mean (range)): 83.4 (50 to 102) years
- Gender (M/F): 28/157
- Mobility assessment (preoperative mobility, mean (SD)): 6.2 (± 2.8)
- Cognitive status (mini mental test score, mean (SD)): 7.8 (± 2.8)
- ASA status (I/II/III/IV): 5/112/70/3
- Fracture classification (A1/A2/A3): n = 44/89/57

Note: study authors did not report: smoking history, medication, BMI, waiting time for surgery

Interventions	**General details:** pre- and postoperative care was the same for both groups; single-dose antibiotic teicoplanin and gentamicin at induction; anaesthesia was either regional, regional and general, or general; traction table for closed reduction; standard operative technique either recommended by the manufacturer or by previous studies; antibiotic and thromboembolism prophylaxis was routinely given; aspirin once daily for 6 weeks; standardised pain relief; mobilised (fully weight-bearing) on the POD1; rehabilitation was standardised; clinical follow-up at six weeks, 6 and 12 months; specialist registrar under supervision or by a consultant who was familiar with both procedures; claimed but also referral to possible influenced of learning curve on some outcomes **Intervention group 1** • Long Holland intramedullary nail (Biomet, Swindon, UK); the nail is locked proximally into the femoral neck with two partially threaded cannulated screws and can be locked distally with two static screws; details of distal locking were not provided by the study authors. • Randomised = 92; 76 at 12-month follow-up (16 died) **Intervention group 2** • CHS (Biomet, Swindon, UK) • Randomised = 98; 80 at 12 month follow up (17 died, 2 fixation failure)
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; radiographic screening time; number of patients transfused; cut-out of the implant; re-fracture around the implant; reoperation; superficial wound infection; deep wound infection; pneumonia; DVT; PE; TIA; mortality; failure to regain mobility; mobility score; days until mobilisation; length of follow-up: mean 12 months **Outcomes relevant to the review:** mortality (30 days and 12 months); mobility (12 months); complications, all at 12 months: blood transfusion; superficial infection; DVT; PE; chest infection; plate/screw failure (reported as implant failure); cut-out; deep infection; postoperative fracture; non-union; unplanned return to theatre
Notes	**Funding/sponsor/declarations of interest:** study authors clearly state that no funding was received and no conflicts existed **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Patients were allocated a sequential study number and were randomised by computer to be treated with a DHS or a Holland nail."

Little 2008 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	No additional details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Quote: "Each procedure was carried out by a specialist registrar under supervision or by a consultant who was familiar with both procedures." Comment: The report suggested that the longer operating and radiation times in the Holland nail group "may be a function of the learning curve in its use"
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes. We noted that assessment of mobility also made by independent assessor.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses are explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Lopez 2002

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** Gamma nail versus DHS
Participants	**Total number of randomised participants:** 103 **Inclusion criteria:** trochanteric proximal femoral fractures (no prominent subtrochanteric extension) **Exclusion criteria:** not reported **Setting:** single centre; orthopaedic hospital; Spain **Baseline characteristics** **Intervention group 1** (Gamma nail) • Age (mean (range)): 83.9 (65 to 101) years

Lopez 2002 *(Continued)*

- Gender (M/F): 13/30
- Comorbidities (n)
  - Diabetes mellitis: 7
  - Heart failure: 6
  - Cardiac arrhythmia: 4
  - Renal insufficiency: 1
  - Parkinson's: 3
  - Others: 28
- Place of residence (own home/family home/residential home): n = 13/33/14
- Cognitive level (mean MMSE score): 15.1
- ASA status (mean): 2.47
- Fracture classification (stable/unstable): n = 31/12

Intervention group 2 (DHS)

- Age (mean (range)): 84.4 (67 to 102) years
- Gender (M/F): 23/37
- Comorbidities (n)
  - Diabetes mellitis: 9
  - Heart failure: 9
  - Cardiac arrhythmia: 5
  - Renal insufficiency: 4
  - Parkinson's: 5
  - Others: 35
- Place of residence (own home/family home/residential home): n = 15/24/44
- Cognitive status (mean MMSE score): 16
- ASA status (mean): 2.51
- Fracture classification (stable/unstable): n = 45/15

Note: study authors do not baseline characteristics for: smoking history, medication, BMI or preoperative waiting time

Interventions	**General details:** experience of surgeons is not reported **Intervention group 1** • Gamma intramedullary nail; no further implant or operative details were provided • Randomised = 43 **Intervention group 2** • Dynamic hip screw *;* no further implant or operative details were provided • Randomised = 60
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; postoperative transfusion; change in haematocrit; radiographic screening time; operative fracture of the femur; later fracture of the femur; cut-out of implant; reoperation; wound infection; wound haematoma; DVT; pneumonia; pressure sores; mortality; mobility score; mean time to fracture consolidation; length of follow-up: 12 months **Outcomes relevant to the review:** mortality (12 months); complications: intraoperative fracture, cut-out, postoperative fracture, pneumonia, wound infection, urinary infection; DVT; length of surgery; unplanned return to theatre **Notes** • We did not include data for blood transfusion or mobility because these outcomes were inadequately defined.

Lopez 2002 *(Continued)*

- We have included wound-infection data with data for 'superficial infection'.

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** February 1998 to April 1999

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quasi-randomised according to medical record number
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation because of the methods used for sequence generation.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Various levels of operating experience. The study authors did not describe whether all surgeons were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Data appeared to be complete for all participants.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Matre 2013

Study characteristics

Methods	RCT; parallel design **Review comparison group:** TRIGEN INTERTAN versus SHS
Participants	**Total number of randomised participants:** 684 (697 were initially randomised but 13 were excluded because of preoperative deaths, participants withdrew from study before surgery, and due to not meeting inclusion criteria) **Inclusion criteria:** > 60 years of age; trochanteric or subtrochanteric fracture

Matre 2013 *(Continued)*

Exclusion criteria: pathological fractures

Setting: 5 centres, hospitals, Norway

Baseline characteristics

Intervention group 1 (intramedullary nail)

- Age (mean): 84.1 years
- Gender (M/F): 83/258
- Mobility assessment/use of walking aides (n)
  - Walks outdoors alone: 186
  - Walks outdoors with support: 24
  - Walks indoors alone: 79
  - Walks indoors with support: 26
  - No walking ability: 5
- Place of residence (home/nursing home/other): n = 208/94/33
- Cognitive impairment (yes/no/uncertain): n = 105/192/38
- ASA status (I/II/III/IV): 22/138/164/11
- Fracture classification (A1/A2/A3/subtrochanteric): n = 150/113/71/7
- Additional information
  - Functional status (mean HHS): 68

Intervention group 2 (SHS)

- Age (mean): 84.1 years
- Gender (M/F): 88/255
- Mobility assessment/use of walking aides (n)
  - Walks outdoors alone: 198
  - Walks outdoors with support: 31
  - Walks indoors alone: 77
  - Walks indoors with support: 23
  - No walking ability: 1
- Place of residence (home/nursing home/other): n = 230/62/42
- Cognitive impairment (yes/no/uncertain): n = 68/231/31
- ASA status (I/II/III/IV): 15/143/162/15
- Fracture classification (A1/A2/A3/subtrochanteric): n: = 140/122/68/13
- Additional information
  - Functional status (mean HHS): 69

Note: study authors did not report: smoking history, medication, BMI or waiting time for surgery

Interventions

General details: surgeons participated in at least 5 operations involving use of the INTERTAN nail before they could participate; clinical examinations at 5 days, 3 and 12 months

Intervention group 1

- Intramedullary nail; TRIGEN INTERTAN (Smith & Nephew, Memphis, Tennessee); long and short nails were used, all were locked distally
- Randomised = 341; 84 died and 53 lost to follow-up for in-hospital assessment: pain at rest (n = 283), pain during mobilisation (n = 269), TUG (n = 306) and LOS (n = 341); outcomes analysed at 12 month follow-up: pain (n = 185), TUG (n = 154), HRQoL (EQ-5D, n = 195); overall at 12 months = 204

Intervention group 2

- SHS (Smith & Nephew) or DHS (Synthes, Basel, Switzerland); a trochanteric stabilising plate was used for all A3 fractures

Matre 2013 *(Continued)*

- Randomised = 343; 87 died and 54 lost to follow-up for in-hospital assessment: pain at rest (n = 289), pain during mobilisation (n = 284), TUG (n = 295) and LOS (n = 343); outcomes analysed at 12 month follow-up: pain (n = 192), TUG (n = 160), HRQoL (EQ-5D, n = 199); overall at 12 months = 202

Outcomes	**Outcomes measured/reported by study authors:** duration of the surgery; patients haemoglobin level; number of blood transfusions; LOS; radiographs (quality of fracture reduction + tip-apex distance); EQ-5D questionnaire; postoperative pain - VAS; TUG; LOS; complication and reoperation rates; patients residence; walking ability; HHS; mortality; major complications (failure of osteosynthesis; deep infection or postoperative haematoma requiring surgical intervention; cutout; femoral fracture; removal of whole implants); minor complications (locking screws missing the nail or removal of a single locking or lag screw; surgical removal of a drain) **Outcomes relevant to the review:** pain (VAS at rest and mobilisation; during hospital stay and at 3 and 12 months); mobility (TUG, during hospital stay and at 12 months); HHS (at 3 and 12 months); HRQoL (EQ-5D at 3 and 12 months); unplanned return to theatre (assumed to be 12 months); cut-out; infection; blood transfusions; postoperative fracture; implant failure (all complications at 12 months); mortality (at 4 and 12 months)
Notes	**Funding/sponsor/declarations of interest:** quote: "Smith & Nephew supported the study, but otherwise the company had no influence on the study." Quote: "One or more of the authors received payments or services, either directly or indirectly (i.e., via his or her institution, has had a financial relationship, in the thirty-six months prior to submission of this work, with an entity in the biomedical arena that could be received to influence or have the potential to influence what is written in this work. No author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work" **Study dates:** February 2008 to February 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Block randomisation with varying block size unknown to the surgeon"
Allocation concealment (selection bias)	Low risk	Quote: “sealed, opaque and consecutively numbered envelopes”
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quotes: “Surgeons participated in at least five operations involving use of the Intertan nail before they could participate in the study” “tendency toward more experienced surgeons implanting Intertan nails (p=0.02)” Comment: study authors performed regression analysis which showed that surgeons' formal qualifications did not influence results
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias)	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.

Matre 2013 *(Continued)*

Participant-reported outcomes		
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	Large number of participants lost to follow-up
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Mehdi 2000

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IMHS versus SHS
Participants	**Total number of randomised participants:** 180 **Inclusion criteria:** extracapsular proximal femoral fractures; AO 31 A1, A2, A3; stable and unstable fractures **Exclusion criteria:** not reported **Setting:** single centre; orthopaedic hospital, UK **Baseline characteristics** **Intervention group 1** (IMHS) • Age (mean): 78 years **Intervention group 2** (SHS) • Age (mean): 75 years **Note:** study authors only reported age data
Interventions	**General details:** no surgical details described **Intervention group 1** • IMHS (Smith & Nephew); the implant is 21 cm long, no further operative details were reported regarding proximal or distal locking • Randomised = 90 **Intervention group 2** • SHS (Smith & Nephew) • Randomised = 90

Mehdi 2000 *(Continued)*

Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; operative fracture of the femur; later fracture of femur (none); cut-out of implant; perioperative complication; fracture reduction; wound infection (superficial and deep); mortality; mobility; HHS **Outcomes relevant to the review:** cut-out; intraoperative fractures; deep infection **Note:** because of the large range of final follow-up times and high and unequal losses to follow-up, we decided against presenting final follow-up results (mortality, later fracture and mobility) in the review.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported **Note:** abstract only published. We received an unpublished report by the study author.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	Quote: "Patients ... were randomised .. at the daily trauma meeting by drawing sealed envelopes." Comment: study authors do not report whether envelopes are opaque and sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote: "A three-month period of familiarisation with the IMHS, prior to the trial, was undertaken to avoid bias. Despite that, all surgeons were more familiar with the Richards Classic Hip Screw..."
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No losses were reported. However, the study is reported only in an abstract and we could not be certain of attrition.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	High risk	The study is reported only as an abstract, which we expected was not peer-reviewed and therefore at high risk of bias.

Michos 2001

Study characteristics

Michos 2001 *(Continued)*

Methods	RCT; parallel design **Review comparison group:** Gamma nail versus SHS
Participants	**Total number of randomised participants:** 52 **Inclusion criteria:** trochanteric proximal femoral fractures. Some may have had subtrochanteric extension. **Exclusion criteria:** not reported **Setting:** single site; orthopaedic hospital, Greece **Baseline characteristics** **Intervention group 1** (Gamma nail) • Age (mean): 79 years **Intervention group 2** (SHS) • Age (mean): 78 years **Note:** study authors did not report: smoking history, medication, comorbidities or cognitive status/dementia;
Interventions	**General details:** experience of surgeon is not reported **Intervention group 1** • Gamma nail; no further details • Randomised = 26 **Intervention group 2** • SHS; no further details • Randomised = 26
Outcomes	**Outcomes measured/reported by study authors:** operative blood loss; later fracture of the femur; cut-out of implant; non-union; plate detachment; mortality (peri-operative); length of follow-up: 3 to 6 months **Outcomes relevant to the review:** mortality (during perioperative period); LOS; unplanned return to theatre (up to 6 months); cut-out; non-union; postoperative fracture; LOS **Notes** • Follow-up period varied from 3 to 6 months • Study authors reported data for LOS without SD and we did not include these data in meta-analysis; we reported these data in an appendix
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported **Note:** study is reported only as an abstract

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "in fractures without extension to subtrochanteric region the TGN was used"

Michos 2001 *(Continued)*

		Comment: participants were described as randomly allocated to groups but no additional details were reported. Because of the quote (above), we could not be certain whether surgeon bias was present during the selection process.
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses are explained by death, which is expected in this population
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Miedel 2005

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma nail versus Medoff sliding plate
Participants	**Total number of randomised participants:** 217 **Inclusion criteria:** unstable trochanteric (Jensen & Michaelsen type 3 to 5) fractures; subtrochanteric (Seinsheimer) proximal femoral fractures; fractures occurred due to a simple fall **Exclusion criteria:** pathological fractures; rheumatoid arthritis; osteoarthritis; fractures extending more than 5 cm distal to the lesser trochanter **Setting:** single centre; orthopaedic hospital; Sweden **Baseline characteristics** **Intervention group 1** (Gamma nail) • Age (mean (SEM)): 84.6 (± 0.6) years

Miedel 2005 *(Continued)*

- Gender (M/F): 17/92
- Comorbidities, groups A (full health) or B (illness not affecting rehabilitation): n = 45
- Mobility assessment (no walking aids or 1 stick): n = 67
- Place of residence (live independently): n = 92
- Cognitive status/dementia (SPMSQ score, mean (SEM)): 5.7 (± 0.3)
- Fracture classification:
  - Trochanteric fractures (J-M 3/4/5): n = 12/28/53
  - Subtrochanteric fractures (S2B/2C/3A/3B/4/5): n = 1/11/3/1/0/0
- Additional information
  - HQoL, EQ-5D (mean score (SEM)): 0.66 (± 0.03)
  - ADL (indices Katz A or B): n = 82

Intervention group 2 (sliding plate)

- Age (mean (SEM)): 82.7 (± 0.6) years
- Gender (M/F): 24/84
- Comorbidities, groups A (full health) or B (illness not affecting rehabilitation): n = 48
- Mobility assessment (no walking aids or 1 stick): n = 71
- Place of residence (live independently): n = 95
- Cognitive status/dementia (SPMSQ score, mean (SEM)): 5.8 (± 0.4)
- Fracture classification
  - Trochanteric fractures (J-M 3/4/50: n = 11/24/61
  - Subtrochanteric fractures (S2B/2C/3A/3B/4/5): n = 0/6/2/1/1/2
- Additional information
  - HQoL, EQ-5D (mean score (SEM)): 0.63 (± 0.03)
  - ADL (indices Katz A or B): n = 72

Note: study authors did not report any baseline data for: smoking history, BMI or preoperative waiting time

Interventions

General details: fracture table; low-molecular-weight heparin before and for approximately 10 to 14 days after operation; single dose of antibiotic preoperatively; mobilised with full weight-bearing as tolerated; identical care programmes; 50% of operations performed by consultant orthopaedic surgeons

Intervention group 1

- Gamma nail (Stryker Howmedica); diameter 11 mm, length 200 mm; medullary canal reamed to 13 mm distally and 17mm proximally; distal locking screw used in all cases
- Randomised = 109; available at 4 months = 87; at 12 months = 82 (24 died, 3 lost to follow-up)

Intervention group 2

- Medoff sliding plate (Swemac); neck angle 135 degrees; six-hole plate; (Swemac); biaxial dynamisation mode allows dynamisation of the femoral neck and shaft
- Randomised = 108; available at 4 months = 81; at 12 months = 74 (31 died, 3 lost to follow-up)

Outcomes

Outcomes measured/reported by study authors: length of surgery; operative blood loss; postoperative transfusion; operative fracture of the femur; technical failure; later fracture of the femur; cut-out of implant; displacement (medialisation of the femur requiring surgery); reoperation; wound infection (superficial and deep); severe medical complications (cardiac, pulmonary, thromboembolic or cerebrovascular); LOS; discharge location; mortality (available in hospital, at 4 months and at 12 months); mobility; pain; hip function; ADL; HRQoL

Outcomes relevant to the review: unplanned return to theatre (12 months); ADL (Katz A and B, 4 & 12 months); mortality (4 & 12 months); LOS; discharge destination (home; orthopaedic rehabilitation, nursing home); complications: intra-operative fracture; post-operative fracture; superficial and deep infection; cut-out; all at end of follow-up (12 months)

Miedel 2005 *(Continued)*

	Note: we did not include data for HRQoL (EQ-5D) because this outcome was reported in a figure from which we could not confidently extract numerical data.
Notes	**Funding/sponsor/declarations of interest:** supported in part from grants from the Trygg-Hansa Insurance Company, the Swedish Orthopaedic Association, and from Stryker Howmedica (Gamma nail) and Swemac (Medoff sliding plate) **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "The patients were randomised (sealed-envelope system)" Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	Study authors do not report whether envelopes are opaque and sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Quote: only half of the operations in each group "were performed by consultant orthopaedic surgeons". Comment: study authors did not describe whether all surgeons were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes. Some assessment made by independent assessor
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study losses are balanced between groups and mostly explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Mott 1993

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus SHS
Participants	**Total number of randomised participants:** 69 **Inclusion criteria:** trochanteric proximal femoral fractures. Defined as 2, 3 or 4 part with additional classifications for basilar neck/high intertrochanteric (7 fractures) and high subtrochanteric/low intertrochanteric (3 fractures). Reference made to classification according to Jensen's modification of Evans but types not reported **Exclusion criteria:** judged in-operable for medical reasons **Setting:** multi-centre; three orthopaedic hospitals; USA. **Baseline characteristics (overall)** • Age (mean (range)): 75.7 (19 to 99) years • Gender (M/F): 28/41 **Notes** • Study authors did not report: smoking history, medication, BMI, comorbidities, cognitive status/dementia, preoperative waiting times, place of residence or ASA status • Baseline characteristics were not reported by group.
Interventions	**General details:** not reported **Intervention group 1** • Gamma nail; no further details • Randomised = 35; no loss to follow-up reported **Intervention group 2** • SHS; no further details • Randomised = 34; no loss to follow-up reported
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; blood transfusion; operative fracture of the femur; later fracture of the femur; cut-out of implant; reoperation; deep wound infection; superficial wound infection; wound haematoma; DVT; MI; pneumonia; UTI; mortality (1 week); length of follow-up: not stated **Outcomes relevant to the review:** unplanned return to theatre; complications: intraoperative fractures; postoperative fractures; cut-out; deep infection; pneumonia; DVT (time point not clearly reported)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported **Note:** data reported in an abstract. We obtained additional information from the study authors during a previous version of this review.

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**

Mott 1993 *(Continued)*

Random sequence generation (selection bias)	Low risk	Computer-generated random numbers table
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	There was variation in the experience in the three hospitals, with a "continual learning curve" in hospital A, a "one-time" learning curve in hospital B, and no learning curve required in hospital C.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

O'Brien 1995

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus DHS
Participants	**Total number of randomised participants:** 101 participants with 102 fractures **Inclusion criteria:** trochanteric proximal femoral fractures; stable and unstable (Evans) **Exclusion criteria:** fractures > 1 week old; pathological fractures; subtrochanteric fractures **Setting:** single centre; orthopaedic hospital, Canada **Baseline characteristics** **Intervention group 1** (Gamma nail) • Age (mean (range)): 83 (57 to 95) years • Gender (M/F): 9/43 • Mobility assessment/use of walking aides (wheelchair/walker/cane/none): n = 4/7/7/34 • Place of residence (independent/home with family/nursing home): n = 28/6/19 • Fracture classification (stable/unstable): n = 30/23 • Preoperative waiting time (mean): 24 hours

O'Brien 1995 *(Continued)*

- Additional information
  - Prefracture hip pain (yes/no): n = 4/49

Intervention group 2 (DHS)

- Age (mean (range)): 77 (39 to 94) years
- Gender (M/F): 13/32
- Mobility assessment/use of walking aides (wheelchair/walker/cane/none): n = 0/11/6/31
- Place of residence (independent/home with family/nursing home): n = 24/5/20
- Fracture classification (stable/unstable): n = 28/21
- Preoperative waiting time (mean): 24 hours
- Additional information
  - Prefracture hip pain (yes/no): n = 3/46

Note: study authors did not report: smoking history, medication, comorbidities or cognitive status/dementia

Interventions	**General details:** all but 4 participants received prophylactic antibiotics; fracture table; image intensifier; no details of surgeons' experience **Intervention group 1** • Gamma intramedullary nail (Synthes Howmedica); 88% were distally locked • Randomised = 52 (with 53 fractures); losses = 6 (death); analysed for all outcomes = 52 **Intervention group 2** • DHS (Synthes); 135-degree 4-hole plate (> 80% of operations) • Randomised = 49 (with 49 fractures); losses = 1; analysed for all outcomes = 49 **Note:** study authors report that they were unable to contact 18 participants for end of follow-up assessment. Data for end of follow-up (pain and function) were not reported.
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; radiographic screening time; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union (time to union); reoperation; wound infection; deep wound infection; wound haematoma; pneumonia; pressure sores; PE; any medical complication; LOS; mortality; pain at follow-up; loss of independence; loss in mobility (dropped ≥ 1 level in walking-aid dependence) **Outcomes relevant to the review:** mortality (early postoperative period); LOS; complications: superficial and deep infections; intra-operative fracture; post-operative fracture; cut-out; PE; MI; UTI; plate/screw failure (reported as fixation failure); pneumonia; unplanned return to theatre; all at end of follow-up unless otherwise stated (all at 12 months) **Notes** • Follow-up: mean 12 months (range 11 to 82 weeks) • Study authors state that data for pain and function are measured, but study authors do not report these results • Study authors reported data for LOS without SD and we did not include these data in meta-analysis; we reported these data in an appendix
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** November 1989 to April 1991 **Note:** we received additional information from study authors

Risk of bias

O'Brien 1995 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	Quote: "randomly allocated by blind envelope selection" Comment: study authors do not report whether envelopes are opaque, sealed and sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	The study authors describe possible "performance bias" during the operation; we have judged this to mean that surgeons were not equally experienced with both implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Although 18% of participants were lost to follow-up (because study authors were unable to contact participants), data for these outcomes are not included in the study report. We have assumed data for complications are for all participants.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Ovesen 2006

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Trochanteric Gamma intramedullary nail versus DHS
Participants	**Total number of randomised participants:** 150 participants with 151 fractures (see Notes) **Inclusion criteria:** intertrochanteric fractures; AO 31 A11, A2 & A3 **Exclusion criteria:** subtrochanteric or a pathological fracture **Setting:** single centre; orthopaedic hospital; Denmark **Baseline characteristics** **Intervention group 1** (TGN)

Ovesen 2006 *(Continued)*

- Age (mean (SD)): 79.9 (± 10) years
- Gender (M/F): 20/53
- Mobility assessment, walking ability (outdoor independent/outdoor with company/inside independent/inside with company/can't walk/missing): n = 54/6/8/1/0/4
- Use of walking aides (sticks, crutches or no aid/frame or chair/missing): n = 50/22/1
- Place of residence (own home/nursing home/missing): n = 62/10/1
- ASA status (I/II/III/IV): 20/21/25/7
- Fracture classification (A1/A2/A3): n = 23/44/6

Intervention group 2 (DHS)

- Age (mean (SD)): 78.5 (± 11.7) years
- Gender (M/F): 21/52
- Mobility assessment, walking ability (outdoor independent/outdoor with company/inside independent/inside with company/can't walk/missing): n = 53/4/12/0/1/3
- Use of walking aides (sticks, crutches or no aid/frame or chair/missing): n = 50/22/1
- Place of residence (own home/nursing home/missing): n = 61/8/4
- ASA status 9I/II/III/IV): 19/18/26/10
- Fracture classification (A1/A2/A3): n = 17/52/4

Notes

- Study authors did not report: smoking history, medication, comorbidities, cognitive status/dementia; mobility; age or gender
- Study authors stated no difference between groups

Interventions	**General details:** prophylaxis for DVT and PE once daily starting from admission until mobilisation; antibiotic prophylaxis; fracture table; fluoroscopy; clinical follow-up at 4 and 12 months **Intervention group 1** • Trochanteric Gamma intramedullary nail (Stryker); distal femur reamed to 13 mm; proximal femur to 18 mm; study authors do not report the length of the nail used however from this it is likely that a standard short nail was used for all cases. • Randomised = 73; 3 lost to follow-up at 4 months and 11 at 12 months **Intervention group 2** • DHS (Synthes); trochanteric stabilising plates were used in two cases • Randomised = 73; 4 lost to follow-up at 4 months and 4 at 12 months **Note:** 5 exclusions after randomisation: 2 wrong initial diagnosis; 3 transferred to other hospitals. We have not included these exclusions in the numbers randomised to each group.
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; transfusion; operative fracture of the femur (none); later fracture of the femur; cut-out of implant; non-union (none); reoperation; wound infection; medical complications (none); LOS; mortality at 12 months; use of walking aids at discharge and 4 months; length of follow-up: 12 months **Outcomes relevant to the review:** mortality (at 4 and 12 months); LOS; complications: intraoperative fracture; postoperative fracture; non-union; cut-out; deep infection; unplanned return to theatre (at 12 months); blood transfusions; mobility (categorical: sticks, crutches or no walking aid; walking frame or wheelchair; at 4 months) **Notes** • Major fracture complications were defined as a failure requiring reoperation, either a refracture of the femur, redislocation, cut-out of the lag screw, haematoma or a deep infection • Three cases of redislocation of the fracture with major loss of reduction and/or implant position. We included these as cases of cut-out.

Ovesen 2006 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** April 2001 and October 2003 **Note:** we received additional information from the study authors

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote (from direct communication with study authors): "computer generated"
Allocation concealment (selection bias)	Low risk	Quote: "patients were randomized by consecutive drawing of opaque envelopes". Comment: envelopes were confirmed as sealed in direct communication with the study author
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Over two-thirds of operations done by residents: 49 surgeons participated in trial. The study authors did not describe whether surgeons were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few losses, which were balanced between groups and explained by study authors
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Pahlpatz 1993

Study characteristics

Methods	RCT; parallel design

Pahlpatz 1993 *(Continued)*

	Review comparison group: Gamma intramedullary nail versus DHS

Participants	**Total number of randomised participants:** 153
	
	Inclusion criteria: trochanteric and subtrochanteric proximal femoral fractures; stable, unstable and subtrochanteric (Evans classification)
	
	Exclusion criteria: multiple fractures; open epiphyseal lines
	
	Setting: single centre; orthopaedic hospital, Netherlands
	
	Baseline characteristics
	
	Intervention group 1 (Gamma nail)
	
	• Fracture classification (stable/unstable/subtrochanteric): n = 35/16/7
	• Additional information
	  ◦ Level of independence: Broos I and II = 39; III and IV = 19
	
	Intervention group 2 (DHS)
	
	• Fracture classification (stable/unstable/subtrochanteric): n = 39/14/2
	• Additional information
	  ◦ Level of independence: Broos I and II = 37; III and IV = 18
	
	Baseline characteristics (overall)
	
	• Age (mean (range)): NR
	• Gender (M/F): 18% male
	
	Notes
	
	• Study authors did not report: smoking history, medication, comorbidities, cognitive status/dementia; mobility; age or gender
	• Surgery mostly within 24 hours, but sometimes postponed for up to 5 days to improve patient cardiopulmonary status

Interventions	**General details:** mostly performed ≤ 24 hours; fracture table with image intensifier; operations by surgical residents with assistance of staff member as required; closed reductions; full weight-bearing day after operation **Intervention group 1** • Gamma intramedullary nail (Howmedica); distal locking was performed at the discretion of the surgeon for stable fractures; distal locking was always performed of unstable fracture patterns • Randomised = unknown; losses unknown; analysed = 58 **Intervention group 2** • SHS (Synthes); 135-degree, 4 holes; unless unstable or subtrochanteric who received longer plates • Randomised = unknown; losses unknown; analysed = 55 **Note:** details of withdrawals: 1 second fracture; 1 did not receive randomised treatment
Outcomes	**Outcomes measured/reported by study authors:** mortality; failure to regain residential status; length of follow-up: 6 months minimum **Outcomes relevant to the review:** ADL (report as change in independence at 3 and 6 months); mortality (3 months and 6 months) **Note:** we reported categorical data for ADL in an appendix.
Notes	**Funding/sponsor/declarations of interest:** not reported

Pahlpatz 1993 *(Continued)*

Study dates: July 1989 to January 1991

Note: study report indicates that these are preliminary study results. No additional results have since been made available.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Within each group [stable trochanteric, unstable trochanteric; subtrochanteric fractures] the patients were non-selectively randomised ..." Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Quote: "Most of the procedures were done by surgical residents ..., if necessary with the assistance of a member of the staff." Comment: study authors did not describe whether surgeons were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	Number of participants randomised to each group is not reported. We noted that 45 participants were not included in analysis, and these losses were not explained.
Selective reporting (reporting bias)	High risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents. We note that this is reported as preliminary results for a limited number of outcomes. The full study report has never been published.
Other bias	Low risk	We identified no other sources of bias.

Pajarinen 2005

Study characteristics

Methods	RCT; parallel design **Review comparison group:** PFN versus DHS

Pajarinen 2005 *(Continued)*

Participants	**Total number of randomised participants:** 108 **Inclusion criteria:** low-energy extracapsular pertrochanteric femoral fractures (AO category 31-A) **Exclusion criteria:** pathological fractures; multiple injuries **Setting:** single centre; orthopaedic hospital; Finland **Baseline characteristics** **Intervention group 1** (PFN) • Age (mean (SD)): 80.9 (± 9.1) years • Gender (M/F): 13/41 • BMI (mean (SD)): 21.4 (± 3.0) kg/m2 • Mobility assessment/use of walking aids (no aids/aids but independent/needs assistance/not reported): n = 31/19/4/0 • Place of residence (own home/nursing home/institution): n = 36/12/6 • Dementia (n): 12 • ASA status (I/II/III/IV): 0/6/28/20 • Preoperative waiting time (mean (SD)): 1.3 (± 1.1) days • Fracture classification (A1.1/A1.2/A2.1/A2.2/other): n = 9/12/12/14/7 **Intervention group 2** (DHS) • Age (mean (SD)): 80.3 (± 10.8) years • Gender (M/F): 14/40 • BMI (mean (SD)): 22.3 (± 3.6) kg/m2 • Mobility assessment/use of walking aids (no aids/aids but independent/needs assistance/not reported): n = 34/19/0/1 • Place of residence (own home/nursing home/institution): n = 33/16/5 • Dementia (n): 14 • ASA status (I/II/III/IV): 0/8/32/14 • Preoperative waiting time (mean (SD)): 1.5 (± 2.4) days • Fracture classification (A1.1/A1.2/A2.1/A2.2/other): n = 7/19/14/10/4 **Overall** • Age (mean (SD)): 80.6 (± 9.9) years • Gender (M/F): 27/81 • BMI (mean (SD)): 21.8 (± 3.3) kg/m2 • Mobility assessment/use of walking aids (no aids/aids but independent/needs assistance/not reported): n = 65/38/4/1 • Place of residence (own home/nursing home/institution): n = 69/28/11 • Dementia (n): 26 • ASA status (I/II/III/IV): 0/14/60/34 • Preoperative waiting time (mean (SD)): 1.4 (± 1.8) days • Fracture classification (A1.1/A1.2/A2.1/A2.2/other): n = 16/31/26/24/11 **Note:** study authors did not report: smoking history, medication, comorbidities or cognitive status/dementia
Interventions	**General details:** operations usually performed within 2 days of admission; in most cases by a senior orthopaedic resident (study authors confirmed all surgeons were experienced in both procedures); closed reduction; prophylactic antibiotics; low-molecular-weight heparin during hospital stay; weight-bearing on POD 1 or POD 2; clinical examinations at 6 weeks and 4 months **Intervention group 1**

Pajarinen 2005 *(Continued)*

- PFN (Synthes-Stratec); all nails were locked proximally with 2 dynamic screws, study authors did not provide information about distal locking or the length of the nails but it is probable that all nails were 240 mm long
- Randomised = 54; analysed at 4 months for mortality = 42

Intervention group 2

- DHS (Synthes-Stratec, Switzerland)
- Randomised = 54; analysed at 4 months for mortality = 41

Note: study authors report that 21 participants were not eligible for analysis; these data were reported overall rather than by group (died in immediate post-operative period = 2; died before completion of follow-up = 4; did not attend final follow-up = 15). In addition, 4 people had revision surgery and were excluded from analysis.

Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; units of blood transfused; later fracture of femur; cut-out; failure of fixation (redisplacement); reoperation; superficial wound infection; deep wound infection; DVT; femoral neck and shaft shortening on X-ray; LOS; mortality; failure to regain pre-fracture residential status; non-recovery of previous mobility; length of follow-up: 4 months **Outcomes relevant to the review:** discharge destination; LOS; unplanned return to theatre; mobility (categorical: no aids needed; in need of aids, but independent, in need of assistance; at 4 months); mortality (at 4 months); complications: superficial infection; cut-out; deep infection; postoperative fracture; DVT
Notes	**Funding/sponsor/declarations of interest:** quote: "no benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article" **Study dates:** October 1999 and February 2001 **Note:** study authors supplied additional information and confirmed that the participants of a separately reported radiological study were also ("for most parts of the series") in the trial

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "strict randomisation" Comment: method used to generate random sequence is not described
Allocation concealment (selection bias)	Low risk	Quote: "The mode of treatment was determined by strict randomisation, using sealed envelopes." Comment: study author confirmed during direct communication that "it was impossible to see the number through the envelope".
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quotes (from direct communication with study authors): "both procedures are standard procedures at our clinic" and "our surgeons are very experienced"
Blinding of outcome assessment (detection bias)	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.

Pajarinen 2005 *(Continued)*

Clinically-assessed subjective outcomes		
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	25 participants were not included in final analysis and most of these losses were because participants were too ill to attend final follow-up. The study authors did not report attrition by group.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Papasimos 2005

Study characteristics	
Methods	RCT; parallel design; 3 study arms **Review comparison group:** PFN versus TGN versus DHS **Note:** in analysis, we combined the data from the 2 intramedullary groups.
Participants	**Total number of randomised participants:** 141 **Inclusion criteria:** unstable trochanteric proximal femoral fracture (see Notes); AO 31-A2 and A3; > 60 years of age **Exclusion criteria:** unable to walk before injury; pathologic fractures; previous ipsilateral hip or femur surgery; any fracture with extension 5 cm distal to the inferior border of the lesser trochanter; stable trochanteric fractures classified as AO Type 31-A1 **Setting:** single centre; orthopaedic hospital; Greece **Baseline characteristics** **Intervention group 1** (PFN) • Age (mean): 79.4 years • Gender (M/F): 17/23 • ASA status (I/II/III/IV): 15/11/14/0 • Fracture classification (A2/A3): n = 24/16 • Additional information ◦ Functional status (Salvati 1973, from 0 to 40 with higher scores indicating greater function; > 30/20 to 29/< 20): n = 31/5/4 **Intervention group 2** (TGN) • Age (mean): 82.8 years

Papasimos 2005 *(Continued)*

- Gender (M/F): 16/24
- ASA status (I/II/III/IV): 14/11/15/0
- Fracture classification (A2/A3): n = 26/14
- Additional information
  - Functional status (Salvati 1973, from 0 to 40 with higher scores indicating greater function; > 30/20 to 29/< 20): n = 30/6/ 4

Intervention group 3 (DHS)

- Age (mean): 81.4 years
- Gender (M/F): 14/26
- ASA status (I/II/III/IV): 13/10/17/0
- Fracture classification (A2/A3): n = 27/13
- Additional information
  - Functional status (Salvati 1973, from 0 to 40 with higher scores indicating greater function; > 30/20 to 29/< 20): n = 29/6/5

Note: study authors did not report: smoking history, medication, BMI, comorbidities, cognitive status/dementia, mobility or preoperative waiting time

Interventions	**General details:** 4 surgeons (extensive experience of TGN and DHS but limited with PFN); prophylactic antibiotics intraoperatively and 2 doses postoperatively; subcutaneous low-molecular heparin for 6 weeks; rehabilitation was identical in all groups; mobilisation on the second postoperative day and subsequent ambulation with weight bearing as tolerated **Intervention group 1** • PFN (Synthes); 11 mm or 12 mm diameter PFN; all nails were locked proximally with 2 screws and distally; the standard 240 mm nail was used • Randomised = unknown; losses = not reported by group; analysed = 40 **Intervention group 2** • TGN (Stryker-Howmedica); 180 mm long; 135 degree with 17 mm proximal diameter and 11 mm distal diameter and distal locking in all participants • Randomised = unknown; losses = not reported by group; analysed = 40 **Intervention group 3** • SHS AMBI (Smith & Nephew); AMBI means the barrel is not keyed and so the lag screw can rotate • Randomised = unknown; losses = not reported by group; analysed = 40 **Note:** "Non-survivors prior to first postoperative year (ten patients) and those who lost last follow-up evaluation (11 patients) were excluded leaving a total of 120 patients for the outcome analysis"
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; radiographic screening time; operative fracture (some of greater trochanter); cut-out of implant; later fracture of the femur; non-union; reoperation; superficial wound infection; haematoma; medical complications; chest infection; pneumonia; mental disturbances; DVT; PE; urinary infection; LOS; time to fracture consolidation; function: scores using Salvati 1973; length of follow-up: mean 12 months **Outcomes relevant to the review:** functional status (Salvati 1973; at 12 months); intraoperative fracture; postoperative fracture; non-union; cut-out; chest infection; venous thromboembolic phenomena (DVT and PE); UTI; superficial infection; mortality (during hospital stay); LOS; unplanned return to theatre (at 12 months), all within 12-month follow-up period; LOS **Note:** study authors reported data for function and LOS without SD and we did not included these data in meta-analysis; we reported these data in an appendix
Notes	**Funding/sponsor/declarations of interest:** not reported

Papasimos 2005 *(Continued)*

Study dates: January 2000 to December 2003

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Patients were... strictly randomised" Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Four surgeons were involved; statement that there was "good enough experience with each implant in the clinic". However, the Discussion also refers to "our immature learning curve". However, the care programmes including rehabilitation in the three groups were the same.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	Number of participants randomised to each group is not reported. Attrition included 11 participants lost to follow-up and 10 deaths (data for participants who died in first postoperative year are not reported).
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Park 1998

Study characteristics

Methods	Quasi-RCT; parallel design **Review comparison group:** Gamma AP (Asia-Pacific) intramedullary nail versus CHS
Participants	**Total number of randomised participants:** 60 **Inclusion criteria:** intertrochanteric femoral fracture. Tronzo classification: stable (II) and unstable (III & IV) **Exclusion criteria:** not reported **Setting:** single centre; University Hospital, South Korea

Park 1998 *(Continued)*

	Baseline characteristics **Intervention group 1** (Gamma nail) • Age (mean): 73.7 years • Gender (M/F): 10/20 • Mobility assessment (independent/aided/bed bound): n = 22/8/0 • ASA status (I/II/III/IV): n = 3/19/8/0 • Fracture classification (Tronzo II stable/Tronzo III and IV unstable): n = 14/16 **Intervention group 2** (CHS) • Age (mean): 72.2 years • Gender (M/F): 14/16 • Mobility assessment (independent/aided/bed bound): n = 19/11/0 • ASA status (I/II/III/IV): n = 4/16/9/1 • Fracture classification (stable/unstable): n = 11/19 **Overall** • Age (mean (range)): 73 (all > 60) years **Note:** study authors did not report: smoking history, medication, BMI, comorbidities, cognitive status/dementia or preoperative waiting time
Interventions	**General details:** only limited details of clinical management reported. Mobilisation in Gamma nail group started using crutches 2 weeks after operation. In CHS group, people with unstable fractures were allowed to bear weight after minimal callus was evident on radiographs **Intervention group 1** • Gamma nail Asia-Pacific (Howmedica) short nail, no implant or operative details were reported • Randomised = 30 **Intervention group 2** • CHS; no implant or operative details were reported • Randomised = 30
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; operative fracture of femur (none); later fracture of femur (greater trochanter); cut-out of implant; non-union (time to union); wound infection; varus deformity; mobility **Outcomes relevant to the review:** mobility (independent or with stick, at 3 months); complications: intra-operative fracture; postoperative fracture; cut-out; deep infection; non-union **Note:** mean follow-up was for 18.5 months (12 to 31 months) but mobility reported at 3 months
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** January 1993 and June 1995 **Note:** Gamma AP nail is a modification of the standard Gamma intramedullary nail for use in patients from Asia

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "prospectively randomised into two groups based on their medical record numbers"

Park 1998 *(Continued)*

Allocation concealment (selection bias)	High risk	It is not feasible to conceal allocation because of the methods used to allocate participants to groups.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	No information.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	High risk	We noted differences in mobilisation practices between groups. In the Gamma nail group, this was started using crutches 2 weeks after operation. In the CHS group, people with unstable fractures were allowed to bear weight after minimal callus was evident on radiographs.

Parker 2012

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: Targon PFN versus SHS
Participants	**Total number of randomised participants:** 598 patients with 600 fractures **Inclusion criteria:** trochanteric hip fractures **Exclusion criteria:** subtrochanteric fractures, subtrochanteric extension that required a plate longer than 5 holes, pathological fractures, previously-treated fractures, conservative treatments, people with senile dementia, people with significant arthritis to be treated with THA **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1** (PFN) • Age (mean (range)): 82.4 (26 to 104) years

Parker 2012 *(Continued)*

- Gender (M): 52
- Mobility assessment, Parker mobility score (higher scores indicate better mobility) (mean): 4.1
- Place of residence (own home): n = 230
- Cognitive status (mean MMTS): 6.1
- ASA status (mean): 2.7; ASA I or II: n = 99
- Fracture classification (displaced intracapsular/basal fracture/stable trochanteric (A1)/unstable trochanteric (A2)/transtrochanteric (A3)): 1/10/48/211/30

Intervention group 2 (SHS)

- Age (mean (range)): 81.4 (27 to 104) years
- Gender (M): 69
- Mobility assessment (Parker mobility score, mean): 4.3
- Place of residence (own home): n = 219
- Cognitive status (MMTS, mean): 6.1
- ASA status (mean): 2.7; ASA I or II: n = 107
- Fracture classification (displaced intracapsular/basal fracture/stable trochanteric (A1)/unstable trochanteric (A2)/transtrochanteric (A3): n = 0/9/56/207/28

Note: study authors do not report baseline characteristics for: smoking history, medication, BMI, co-morbidities or preoperative waiting time

Interventions	**General details:** all undertaken or supervised by a single specialised hip fracture surgeon; early mobilisation with full weight-bearing, early discharge to previous residence when possible **Intervention group 1** • Targon PFN; standard nail 220 mm long, 130° angle telescoping, screw and barrel and anti-rotation pin, distal locking with single 4.5 mm screw • Randomised = 300; 215 completed 12 month follow-up; 83 lost to mortality; 2 lost to follow-up (at 12 months) **Intervention group 2** • SHS (Biomet Ltd, Bridgend, UK); 4-hole plate unless A3 fracture which used 5-hole; lag screw ≤ 80 mm • Randomised = 300; 215 completed 12 month follow-up; 81 lost to mortality; 4 lost to follow-up (at 12 months) **Note:** study authors do not report type of anaesthesia; use of preoperative or postoperative antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 6 weeks and 3, 6, 9 and 12 months); acute ward stay; blood transfusion and volume of transfused blood; non-union; avascular necrosis; reoperation (arthroplasty or revision fixation); superficial and deep wound infection; confusion/delirium; pneumonia; pressure sores; urine retention; DVT; PE; fat embolism; CVA; MI; clostridia diarrhoea; gastrointestinal bleed; peritonitis; septicaemia; acute renal failure; pain (Charnley scale at 2, 3, 6, 9 and 12 months; VAS; using a 6-point scale at 6 weeks, lower scores indicates no pain); available at 6 weeks and 3, 6, 9, 12 months); mobility score (9-point scale: 1 = no need for mobility aids; available at 8 weeks and 3, 6, 9, 12 months); penetration of lag screw, plate detachment from femur, fracture below implant **Outcomes relevant to the review:** mortality (at 3 and 12 months); unplanned return to theatre; hospital LOS (acute ward stay); blood transfusion; cut-out; non-union; delirium/confusion; pneumonia; DVT; PE; CVA; MI; unplanned return to theatre (arthroplasty or revision fixation); superficial wound infection; deep infection; pain (Charnley scale, using a 6-point scale, lower scores indicates no pain; at 3 months and 12 months); mobility score (9 point scale: 1 = no need for mobility aids; at 3 months and 12 months); LOS
Notes	**Funding/sponsor/declarations of interest:** funded internally from the Peterborough Hospitals Hip Fracture Research Fund to cover research expenses and those of the research nurse. Study author re-

Parker 2012 *(Continued)*

ceived benefits for personal or professional use from a commercial party related directly or indirectly to the study

Study dates: April 2002 to November 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Envelopes were prepared by a person who was independent to the study.
Allocation concealment (selection bias)	Low risk	Use of sealed opaque, numbered envelopes
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	All surgeries were undertaken by a single surgeon experienced with both implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes (such as decision to reoperate).
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	Quote: "All assessments were made by a nurse who was blinded to the treatment allocation" Comment: we assumed that these nurse-led assessments were for outcomes that also included participant assessment such as pain and mobility
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most study losses are explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trials registration or a prepublished protocol. It is not possible to effectively assess risk of reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Parker 2017

Study characteristics

Methods	RCT; parallel design **Review comparison group**: Targon PFN versus SHS

Parker 2017 *(Continued)*

Participants	**Total number of randomised participants:** 400 **Inclusion criteria:** surgically treated trochanteric fractures (stable A1, unstable A2, and transtrochanteric A3); patients with dementia were included with consent next of kin **Exclusion criteria:** subtrochanteric fractures; subtrochanteric extension that required a plate longer than 5 holes; pathological fractures; previously treated fractures; conservative treatments; patients with senile dementia for whom permission of their next of kin was not obtained; arthritis of the hip **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1** (PFN) • Age (mean (range)): 82 (36 to 101) years • Gender (M/F): 60/140 • Mobility assessment (Parker mobility score, mean): 3.8 • Place of residence (own home): n = 164 • Cognitive status (MMTS, mean): 6.7 • ASA status (mean): 2.7; ASA I or II: n = 68 • Fracture classification (basal fracture/stable trochanteric (A1)/unstable trochanteric (A2)/ transtrochanteric (A3)): n = 4/38/141/17 **Intervention group 2** (SHS) • Age (mean (range)): 83.2 (25 to 105) years • Gender (M/F): 47/153 • Mobility assessment (Parker mobility score, mean): 3.7 • Place of residence (home): n = 160 • Cognitive status (MMTS, mean): 6.7 • ASA status (mean): 2.7; ASA I or II: n = 72 • Fracture classification (basal fracture/stable trochanteric (A1)/unstable trochanteric (A2)/ transtrochanteric (A3)): n = 3/27/156/14 **Note:** study authors do not report baseline characteristics for: smoking history, medication, BMI, co-morbidities or preoperative waiting time
Interventions	**General details:** all undertaken or supervised by a single specialised hip fracture surgeon; early mobilisation with full weight-bearing, early discharge to previous residence when possible **Intervention group 1** • Targon PFT (B. Braun, Tuttlingen, Germany); 220 mm nail, locked proximally with a screw and derotation pin, locked distally with a single dynamic screw • Randomised = 200; 59 lost to mortality; 1 lost to follow-up (at 12 months) **Intervention group 2** • SHS (Biomet Ltd, Bridgend, UK); four- or five-hole 135° plate • Randomised = 200; 60 lost to mortality; 1 lost to follow-up (at 12 months) **Note:** study authors do not report type of anaesthesia; use of preoperative or postoperative antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 30 days, 8 weeks and 3, 6, 9 and 12 months); acute ward stay; blood transfusion and volume of transfused blood; confusion/delirium; non-union; avascular necrosis; reoperation (arthroplasty or revision fixation); superficial and deep wound infection; pneumonia; DVT; CVA; MI; acute renal failure; pain (using a 6-point scale in the first 600 participants, and a 9-point scale in the later 400 participants - in both scales lower scores indicates

Parker 2017 *(Continued)*

	no pain; available at 8 weeks, 3 months, 6 months, 9 months, 12 months); mobility score (9-point scale: 1 = no need for mobility aids; available at 8 weeks and 3, 6, 9, 12 months); pressure sores, urine retention, PE, congestive cardiac failure, cardiac arrhythmia, gastrointestinal bleed, peritonitis, intestinal obstruction, clostridia diarrhoea, septicaemia, fat embolism; cut-out, plate off the femur or fracture below implant **Outcomes relevant to the review:** mortality (at 3 and 12 months); unplanned return to theatre; hospital LOS (acute ward stay); blood transfusion; confusion/delirium; cut-out; non-union; unplanned return to theatre; superficial wound infection; deep infection; pneumonia; DVT; CVA; MI; acute renal failure; pain (9-point scale; lower scores indicates no pain; at 3 months and 12 months); mobility score (9-point scale: 1 = no need for mobility aids; at 3 months and 12 months); cut-out
Notes	**Funding/sponsor/declarations of interest:** funded internally from the Peterborough Hospitals Hip Fracture Research Fund to cover research expenses and those of the research nurse. Study author received benefits for personal or professional use from a commercial party related directly or indirectly to the study **Study dates:** December 2010 to September 2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Participants were randomised by the opening of numbered opaque sealed envelopes. No further information in the paper or the 2012 or 2017 publications
Allocation concealment (selection bias)	Low risk	Patients were randomised by the opening of numbered opaque sealed envelopes to fixation of the fracture with either the SHS or an intramedullary nail.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	All surgeries were undertaken by a single surgeon experienced with both implants.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes (such as decision to reoperate).
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding of participants to influence reporting of these outcomes. Data were collected from participants by a research nurse who was unaware of treatment allocation.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses are explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	The study was retrospectively registered on a clinical trials register (NCT02680028; first posted February 2016 and NCT03172923; June 2017); it is

Parker 2017 *(Continued)*

		not feasible to effectively assess risk of selective reporting bias from this document.
Other bias	Low risk	We identified no other sources of bias.

Pelet 2001

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma nail versus angled plate

Participants	**Total number of randomised participants:** 26
	
	Inclusion criteria: trochanteric proximal femoral fractures, classified by the system of Kyle as type IV. These are equivalent to type A3 (AO classification): reversed and transverse fracture lines at the level of the lesser trochanter
	
	Exclusion criteria: Kyle types I to III; < 16 years of age; refusing to consent; not operated within 4 days
	
	Setting: single centre; orthopaedic hospital; Switzerland
	
	Baseline characteristics
	
	Intervention group 1 (Gamma nail)
	
	• Age (mean (range)): 68.7 (21 to 94) years
	• Gender (M/F): 6/7
	• Mobility assessment (active/sedentary/bedridden): n = 6/5/2
	• ASA status (I/II/III/IV): 2/6/3/1
	• Fracture classification (n)
	  ○ Evans (I/II/III/IV/V): 1/3/2/3/4
	  ○ AO (A1/A2/A3/B/C): 1/7/1/1/3
	
	Intervention group 2 (angled plate)
	
	• Age (mean (range)): 72.9 (21 to 96) years
	• Gender (M/F): 3/10
	• Mobility assessment (active/sedentary/bedridden): n = 6/6/1
	• ASA status (I/II/III/IV): 2/5/2/4
	• Fracture classification (n)
	  ○ Evans (I/II/III/IV/V): 3/2/1/3/3
	  ○ AO (A1/A2/A3/B/C): 0/8/1/1/3
	
	Notes
	
	• Study authors did not report: smoking history, medication, BMI, comorbidities, mobility assessment cognitive status/dementia, preoperative waiting time
	• 6 high-energy fractures

Interventions	**General details:** all operated on within 48 hours; preoperative prophylactic antibiotics; general or epidural anaesthesia; mobilised after 24 hours with weight bearing according to radiographs; clinical follow-up at 10 days, 1, 2, 3,6 and 12 months **Intervention group 1** • Gamma nail; 12 short nails 200mm long and one long nail 400 mm long were used

Pelet 2001 *(Continued)*

- Randomised = 13, no reported loss to follow-up

Intervention group 2

- Angled blade plate, 90 degree; no further details
- Randomised = 13, no reported loss to follow-up

Outcomes	**Outcomes measured/reported by study authors:** quality of the reduction; length of surgery; operative blood loss; operative fracture of the femur; cut-out; non-union (and time to consolidation); avascular necrosis; implant failure; reoperation; wound infection; PE; cardiac failure; all medical complications; LOS; discharge destination, external rotation deformity; hip flexion; mortality; pain at follow-up; use of walking aids; time to start of weight bearing; time to full weight bearing; length of follow-up: 12 months **Outcomes relevant to the review:** mortality (at 12 months); pain (at follow-up); unplanned return to theatre; mobility; LOS; discharge destination (rehabilitation centre or home); complications: intra-operative fracture; cut-out; deep infection; non-union; PE; plate/screw failure **Note:** mobility reported as use of walking aids. We reversed these data in order to capture these data in the review outcome 'independent mobility'.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** November 1993 to January 1995 **Note:** study reported in French

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random numbers method, by drawing of lots
Allocation concealment (selection bias)	Unclear risk	Study authors stated that randomisation was "fully blinded", but no additional information
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	In direct communication with study authors, there "may be more experience in gamma as plate"
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.

Pelet 2001 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Radford 1993

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma intramedullary nail versus DHS
Participants	**Total number of randomised participants:** 200 **Inclusion criteria:** > 60 years of age, pertrochanteric proximal femoral fractures. Stable and unstable fractures (Evans) **Exclusion criteria:** not reported **Setting:** single centre; orthopaedic hospital, UK **Baseline characteristics** **Intervention group 1** (Gamma nail) • Age (mean (range)): 83 (60 to 97) years • Gender (M/F): 79/21 • Comorbidities (diabetes):" n = 6 • Mobility assessment (mobility score, average): 3.9 • Place of residence (housing score, average): 4.3 • Cognitive status/dementia (MMSE < 23/30): n = 24 • Fracture type (unstable): n = 38 **Intervention group 2** (DHS) • Age (mean (range)): 78 (60 to 90) years • Gender (M/F): 76/24 • Comorbidities (diabetes): n = 4 • Mobility assessment (mobility score, average): 3.7 • Place of residence (housing score): 4.1 • Cognitive status/dementia (MMSE < 23/30): n = 21 • Fracture type (unstable): n = 43 **Note** • Study authors did not report: smoking history, medication, BMI or preoperative waiting time • No details provided of housing or mobility scales
Interventions	**General details:** surgeons at registrar level or higher experienced in both techniques and supervised by the study authors; image intensifier; closed reduction where possible; traction table; aimed for cen-

Radford 1993 *(Continued)*

	tral screw position, 5 mm to 10 mm from subchondral bone; suction drains; perioperative antibiotic prophylaxis; mobilised on POD2; clinical review at 3 and 12 months **Intervention group 1** • Gamma intramedullary nail (Howmedica, UK); distal locking performed when longitudinal instability existed; the length of nails used were not reported in the study report but it is probable that all were short nails • Randomised = 100; losses reported were due to mortality = 12 (3 months) **Intervention group 2** • DHS (Stratec Medical, UK); four-hole, 135-degree plate • Randomised = 100; losses reported were due to mortality = 10 (3 months)
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; operative fracture of the femur; later fracture of the femur; cut-out of implant; non-union; reoperation; wound infection; deep wound infection; DVT; LOS; mortality; transfer to long-term care; mobility level; length of follow-up: 12 months **Outcomes relevant to the review:** mortality (3 months); wound infection (superficial and deep, 3 and 9 months respectively); DVT (during hospital stay); intra-operative fracture; cut-out; non-union; post-operative fracture; plate/screw failure (reported as fixation failure); unplanned return to theatre (time point unclear unless stated, assumed to be 12 month as end of follow-up period)
Notes	**Funding/sponsor/declarations of interest:** quote: "No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article" **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Participants were randomly assigned to groups. No additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote: "only surgeons of registrar grade and above .. took part in trial. They were already experienced in the use of the DHS and intramedullary nailing, and were personally instructed in the operative technique for the Gamma nail. ...The first two Gamma nail operations performed by each surgeon were not included in the trial."
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.

Radford 1993 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Reported losses were explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Rahme 2007

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFN versus blade plate

Participants	**Total number of randomised participants:** 60
	
	Inclusion criteria: subtrochanteric proximal femoral fractures, all types (Seinsheimer classification)
	
	Exclusion criteria: ipsilateral femoral shaft or femoral neck fractures
	
	Setting: multi-centre; 2 orthopaedic hospitals; Australia
	
	Baseline characteristics
	
	Intervention group 1 (PFN)
	
	• Age (mean): 73 years
	• Gender (M/F): 13/16
	• Preoperative waiting time (mean): 3.0 days
	• Fracture classification, Seinsheimer classification (n)
	  ○ Type I (undisplaced or displaced < 2 mm): 1
	  ○ Type II (2-part fractures): 7
	  ○ Type III (3-part fractures): 10
	  ○ Type IV (comminuted with ≥ 4 fragments): 1
	  ○ Type V (extension through the greater trochanter): 10
	
	Intervention group 2 (blade plate)
	
	• Age (mean): 67 years
	• Gender (M/F): 12/17
	• Preoperative waiting time (mean): 2.9 days
	• Fracture classification (Seinsheimer classification) (n)
	  ○ Type I (undisplaced or displaced < 2 mm): 0
	  ○ Type II (2-part fractures): 8
	  ○ Type III (3-part fractures): 8
	  ○ Type IV (comminuted with ≥4 fragments): 4
	  ○ Type V (extension through the greater trochanter): 9
	• Study authors did not report: smoking history, medication, BMI, comorbidities, mobility assessment cognitive status/dementia or preoperative waiting time

Interventions	**General details:** bone grafting was at the discretion of the surgeon. Non-weight bearing mobilisation was allowed postoperatively for 12 weeks, or until callus was seen on radiographs

Rahme 2007 *(Continued)*

	Intervention group 1 • PFN (Synthes AG, Chur, Switzerland); no further implant or operative details were provided • Randomised = 30; 1 patient was treated with a SHS **Intervention group 2** • Blade plate (Synthes AG, Chur, Switzerland); 95-degree angled blade plate; no further implant or operative details were provided • Randomised = 30; 1 patient was treated with a PFN
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; mean units of blood transfused; non-union and delayed union; reoperation; wound infection; LOS; mortality; general health (SF-36); length of follow-up: 12 months **Outcomes relevant to the review:** unplanned return to theatre (at end of follow up); LOS; mortality (unclear but assumed to be 12 months); non-union; superficial infection **Note:** study authors did not report numerical data for HRQoL. Quote: "Differences between the 2 groups were not significant in each of the 8 domains"
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** August 2001 and August 2003 **Note:** study stopped early. Quote: "Due to a significantly higher revision rate in the BP group, recruitment was terminated after an interim analysis of the first 50 patients. By this time, 60 patients had been recruited, 30 in each group"

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	One participant in each group was not included in analysis (these participants were treated with an alternative implant). Losses were explained by death. We did not include data for HRQoL (for which losses were explained by death, de-

Rahme 2007 *(Continued)*

		mentia and being uncontactable), because study authors did not report these data.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Raimondo 2012

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** ITST nail versus PCCP plate
Participants	**Total number of randomised participants:** 70 **Inclusion criteria:** not reported; described as elderly patients **Exclusion criteria:** not reported **Setting:** single centre; trauma unit; Italy **Baseline characteristics** (overall) • Age (range): 48 to 98 • Gender (M/F): 10/60 **Notes** • Study authors did not report: smoking history, medication, BMI, comorbidities, mobility assessment cognitive status/dementia or preoperative waiting time • Study authors reported that they matched for age (± 4 years), gender, type of fracture (according to AO and EVANS indexes), comorbidity (evaluated with ASA and Charlson Index) and duration of preoperative hospitalisation
Interventions	**General details:** type of anaesthesia (general or locoregional) was consistent between groups **Intervention group 1** • ITST nail, no further details • Randomised = 35, no losses reported **Intervention group 2** • PCCP plate, no further details • Randomised = 35, no losses reported
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood transfusion; LOS; complications; functional status (HHS, 40 days, 6 and 12 months) **Outcomes relevant to the review:** mortality (12 months); functional status (HHS, 40 days and 12 months); complications: infection, loosening; blood transfusion **Notes** • The authors state that LOS and length of surgery were recorded but not reported. • No losses were reported; it was assumed that all participants recorded functional outcomes.

Raimondo 2012 *(Continued)*

- We assumed infections were superficial.

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** 2006 to 2010 **Note:** study is reported only in an abstract with limited detail on study methodology

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. Because surgeons assessed the subjective outcomes (reoperation and complications), we judged detection bias for subjective outcomes to be high risk.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No losses were reported. However, the study is reported only in an abstract and we could not be certain of attrition.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	High risk	The study is reported only as an abstract, which we expected was not peer-reviewed and therefore at high risk of bias.

Reindl 2015

Study characteristics

Methods	RCT; parallel design

Reindl 2015 *(Continued)*

	Review comparison group: intramedullary devices versus DHS
Participants	**Total number of randomised participants:** 204 **Inclusion criteria:** unstable intertrochanteric hip fracture; ≥ 55 years of age; type 2 (AO/OTA 31 - A2); isolated fracture; occurred < 2 weeks prior to the time of enrolment **Exclusion criteria:** fracture due to malignancy; inability to walk before the fracture; severe dementia; limited life expectancy due to substantial medical comorbidities; medical contraindication; inability to comply with rehab or complete the forms **Setting:** multicentre; 9 sites; Canada **Baseline characteristics** **Intervention group 1** (intramedullary device) • Age (mean (SD)): 82 (± 8.6) years • Gender (M/F): 57/55 **Intervention group 2** (DHS) • Age (mean (SD)): 80 (± 9.9) years • Gender (M/F): 31/61 **Note:** study authors did not report: smoking history, medication, BMI, comorbidities, mobility assessment cognitive status/dementia or preoperative waiting time
Interventions	**General details:** fracture table; attempted closed reduction; use of fluoroscopic guidance; clinical evaluations at 6 weeks and 3, 6 and 12 months **Intervention group 1** • A choice of 3 intramedullary devices: trochanteric fixation nail (Synthes), Gamma nail (Stryker) or Trigen Intertan nail (Smith & Nephew); short nails; dynamic fixation proximally and all were distally locked. • Randomised = 112; devices: 42 = TFN, 48 = Intertan, 22 = Gamma nail; at 3 months = 96; at 12 months = 87 (13 died, 6 unwilling to continue, 5 unknown loss, 1 implant failure) **Intervention group 2** • DHS (Synthes); plate ranges in length from two to six holes at the surgeon's discretion • Randomised = 92; at 3 months = 85; at 12 months = 80 (6 died, 2 unwilling to continue, 2 unknown loss, 2 implant failure)
Outcomes	**Outcomes measured/reported by study authors:** available at 6 weeks and 3, 6 and 12 months: LEM; FIM; TUG; 2MWT; radiographic findings; implant position - tip-apex distance; femoral neck shortening; heterotopic ossification - Brooker stage; complications; length of follow up - 12 months **Outcomes relevant to the review:** analysed at 3 and 12 months: ADL (FIM, 0 to 126, higher scores indicated greater independence); mobility (TUG) and 2MWT; 12 months only: mortality; deep infection; unplanned return to theatre; cut-out **Notes** • The study authors report ADL using 2 measurement tools: FIM and LEM. We have used data from FIM. • The study authors report mobility using 2 measurement tools: 2MWT and TUG. We have used data from the TUG.
Notes	**Funding/sponsor/declarations of interest:** the study was directed by the Canadian Orthopaedic Trauma Society (COTS) with no other conflicts reported

Reindl 2015 *(Continued)*

Study dates: February 2007 to November 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quotes: “Permuted block randomisation”, “randomly generated modality”
Allocation concealment (selection bias)	Unclear risk	Quote: “sealed envelopes” Comment: study authors do not report whether envelopes are opaque and sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Trial appears pragmatic in design. Multi-centre trial with no information available on surgeon expertise
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were balanced between groups and were mostly explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Registration with clinical trials register NCT00597779: first registered in January 2008 although study commenced in February 2007. It was not feasible to effectively assess risk of reporting bias using retrospectively prepared documents. We noted that SF-36 was listed as an outcome, but was later dropped from the outcome list on the clinical trials register and was not reported in the published study report.
Other bias	Low risk	We identified no other sources of bias.

Sadowski 2002

Study characteristics

Methods	RCT; parallel design

Sadowski 2002 *(Continued)*

Review comparison group: PFN versus the DCS

Participants	**Total number of randomised participants:** 39
	
	Inclusion criteria: 31-A3 low-energy fractures; ≥ 55 years of age
	
	Exclusion criteria: pathological fractures; fractures associated with polytrauma; a pre-existing femoral deformity preventing hip screw osteosynthesis or intramedullary nailing; previous surgery on the ipsilateral hip or femur; fractures extending 5 cm distal to the inferior border of the lesser trochanter
	
	Setting: single centre; orthopaedic hospital; Switzerland
	
	Baseline characteristics
	
	Intervention group 1 (PFN)
	
	• Age (mean (SD)): 80 (± 13) years
	• Gender (M/F): 7/13
	• Mobility assessment (Parker scale (9 being greatest mobility), mean (SD)): 6.25 (± 2.36)
	• Place of residence (own home/nursing home): n = 13/7
	• ASA status (I/II/III/IV): 0/6/11/3
	• Additional information
	  ◦ Social function, Jensen score (4 being dependent to 1 being independent), mean (SD): 2.05 (± 0.94)
	
	Intervention group 2 (DCS)
	
	• Age (mean (SD)): 77 (± 14) years
	• Gender (M/F): 5/14
	• Mobility assessment (Parker scale (0 to 9; 9 being greatest mobility), mean (SD)): 7.0 (± 2.52)
	• Place of residence (own home/nursing home): n = 15/4
	• ASA status (I/II/III/IV): 1/9/9/0
	• Additional information
	  ◦ Social function, Jensen score (4 being dependent to 1 being independent), mean (SD): 1.95 (± 0.97)
	
	Note: study authors did not report: smoking history, medication, BMI, comorbidities, cognitive status/dementia or preoperative waiting time

Interventions	**General details:** single dose of prophylactic antibiotics preoperatively; low-molecular-weight heparin from the day of surgery; prophylactic anticoagulation on the fifth postoperative day; performed by staff surgeons on a fracture table; mobilised out of bed on the second postoperative day; walking with weight-bearing as tolerated on the third or fourth day; rehabilitation protocol identical for both groups; surgeons were experienced with both devices (had performed at least eight of each operation before the study) **Intervention group 1** • PFN (Synthes-Stratec); length of nail was not reported but from the text description it is highly probable that all were short nails; interlocked distally with 2 screws • Randomised = 20; at 12 months: 0 lost to follow-up, 2 died, 16 analysed for pain, ADL and mobility; 20 analysed for mortality **Intervention group 2** • DCS (Synthes); 95-degree fixed angle screw-plate, • Randomised = 19; at 12 months: 1 lost to follow-up, 1 died, 17 analysed for pain, ADL and mobility; 19 analysed for mortality
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; mean units transfused; number of patients transfused; radiographic screening time; cut-out; non-union (and time to consolidation); implant failure; reoperation; wound infection; pneumonia; pressure sores; DVT; PE;

Sadowski 2002 *(Continued)*

urinary infection; cardiac failure/infarction; all medical complications; mortality; pain at follow-up; social function; transfer to long term care; mobility level; length of follow-up: 12 months

Outcomes relevant to the review: complications during hospital stay: blood transfusion, UTI, pneumonia, MI, PE, cerebrovascular accident, cut-out, plate/screw failure (reported as implant failure), LOS, discharge destination (home; or nursing home/rehabilitation centre); mortality (in hospital); outcomes at 12 months: mortality, deep infection, non-union; unplanned return to theatre (reported as major reoperation), pain in hip/thigh (from 1 being no pain to 4 severe pain), ADL (Jenson social function score), mobility (Parker scale)

Notes

Funding/sponsor/declarations of interest: study authors clearly report that no grants or outside funding was received

Study dates: March 1998 and June 1999

Notes

- Additional information was supplied by the study authors.
- This study was concurrent with Saudan 2002, but included a different participant group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "No patient refused randomization, which was accomplished with use of computer-generated random numbers."
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote (from direct communication with study authors): "All the surgeons involved in this study had performed an average of eight procedures with the PFN prior to the initiation of the randomized clinical trial."
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were relatively balanced between groups and were mostly explained by death, which is expected in this population.

Sadowski 2002 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Sanders 2017

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: TRIGEN INTERTAN (short and long nails) versus SHS
Participants	**Total number of randomised participants:** 250 **Inclusion criteria:** people with intertrochanteric fractures; ≥ 55 years of age; ambulatory; able to participate in follow-up activities; provided informed consent **Exclusion criteria:** polytrauma; pathological fractures; no fixed address **Setting:** multi-centre (5 level-1 trauma centres); Canada **Baseline characteristics** **Intervention group 1** (intramedullary) • Age (mean (SD)): 80.6 (± 0.8) years • Gender (M/F): 36/87 • Smoking history (never smoked/quit/current smoker): n = 54/46/22 • BMI (mean (SD)): 23.4 (± 0.6) kg/m^2 • Comorbidities (type, n): none reported: 4; heart disease: 64; CVA: 19; lung disease: 29; diabetes 33; kidney disease: 12; anaemia/blood disease: 12; cancer: 17; rheumatoid arthritis: 6; osteoarthritis: 57; depression: 26; Alzheimer's/dementia: 8; affected vision: 6; Parkinson's: 3 • Place of residence (at home/residential care facility/long-term care or hospital): n = 104/11/8 • Preoperative waiting time (median (range)): 2 (0 to 8) days • Fracture classification (31A1/31A2): n = 21/102 **Intervention group 2** (extramedullary) • Age (mean (SD)): 81.0 (± 0.8) years • Gender (M/F): 33/93 • Smoking history (never smoked/quit/current smoker): n = 59/8/19 • BMI (mean (SD)): 24.6 (± 0.6) kg/m2 • Comorbidities (type, n): none reported: 5; heart disease: 59; CVA: 13; lung disease: 31; diabetes 23; kidney disease: 15; anaemia/blood disease: 13; cancer: 18; rheumatoid arthritis: 9; osteoarthritis: 63; depression: 21; Alzheimer's/dementia: 9; affected vision: 6; Parkinson's: 3 • Place of residence (at home/residential care facility/long-term care or hospital): n = 108/12/6 • Preoperative waiting time (median (range)): 2 (0 to 10) days • Fracture classification (31A1/31A2): n = 22/104 **Note:** study authors report no baseline characteristics for: medication, mobility assessment, cognitive status or ASA status
Interventions	**General details:** use of general or spinal anaesthesia; perioperative antibiotics; treated with indirect reduction and percutaneous techniques. Surgeons' preference determined reduction technique, plate

Sanders 2017 *(Continued)*

length, number of screws, use of a compression screw, use of ancillary fixation, nail length (long or short), and number of distal interlocking screws

Intervention group 1

- TRIGEN INTERTAN (Smith & Nephew) - 71 short nails, (49 long INTERTAN) and 3 other long IM nails, dual intergrated proximal screw and distal locking performed at the preference of the operating surgeon
- Randomised = 123 (cross-over to alternative implant in 7); losses variable for each outcome and not all explained (some due to death, some because of missing data); analysed for mortality, reoperation, periprosthetic fracture, TUG, LOS = 123; analysed for FIM and LEM at 3 months = 110; analysed for hardware failure, FIM and LEM at 12 months = 102; analysed for discharge destination = 116

Intervention group 2

- SHS (Smith & Nephew)
- Randomised = 127 (cross-over to alternative implant in 2); losses variable for each outcome and not all explained (some due to death, some because of missing data); analysed for mortality, reoperation, periprosthetic fracture, TUG, LOS = 126; analysed for FIM and LEM at 3 months = 107; analysed for FIM and LEM at 12 months = 91; analysed for discharge destination = 119; analysed for hardware failure = 85

Note: study authors did not report number of clinicians (and their skills and experience), or postoperative rehabilitation, weight-bearing, mobilisation

Outcomes

Outcomes measured/reported by study authors: functional measures (FIM and TUG; 2MWT, LEM; data available at discharge, 6 weeks, 3 months, 6 months, 1 year); union and non-union, complications (screw, plate, and rod breakage; loss of mechanical instability; alignment), place of residence at discharge, LOS, Self-Administered Comorbidities Questionnaire, Geriatric Depression Scale, transfusion rates and haemoglobin level; infection, medical complications, implant failure, or periprosthetic fracture; mortality

Outcomes relevant to the review: mortality (3 and 12 months); ADL (FIM; 3 & 12 months); mobility (people able to complete a TUG; at 3 and 12 months); LOS; unplanned return to theatre (12 months); discharge destination; postoperative fracture; plate/screw failure (reported as screw breakage or penetration)

Notes

- Study authors report ADL using 2 measurement tools: FIM and LEM. We have used data from FIM.
- Study authors measured but did not report data for infection. We did not include data for non-union, which were reported as overall data.
- For TUG, study authors also report median scores which we did not include in the review.
- Study authors reported LOS without distribution values and we did not use these data in meta-analysis; we reported these data in an appendix.

Notes

Funding/sponsor/declarations of interest: unrestricted educational grant from Smith & Nephew Richards

Study dates: 2008 to 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Low risk	"Surgeons were unaware of block size and order"

Sanders 2017 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	We noted loss of participant data for some outcome measures (FIM and LEM), and reasons for these losses were not explained.
Selective reporting (reporting bias)	Low risk	The study was registered on a clinical trials register (NCT00664950, first received April 2008); the reported outcomes were mostly consistent with those in the clinical trial registration documents.
Other bias	Low risk	We identified no other sources of bias.

Saudan 2002

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFN versus DHS
Participants	**Total number of randomised participants:** 206 **Inclusion criteria:** low-energy trochanteric fractures; > 55 years of age **Exclusion criteria:** pathologic fractures; polytrauma; previous ipsilateral hip or femur surgery; any fracture with extension 5 cm distal to the inferior border of the lesser trochanter; AO/OTA Type 31-A3 **Setting:** single setting; orthopaedic hospital; Switzerland **Baseline characteristics** **Intervention group 1** (PFN) • Age (mean (SD)): 83 (± 9.7) years • Gender (M/F): 24/76 • Mobility assessment (Parker scale from 0 to 9, with 9 being most mobile, mean (SD)): 6.3 (± 2.74)

Saudan 2002 *(Continued)*

- Place of residence (own home/nursing home): n = 55/45
- ASA status (I/II/III/IV): 1/30/63/6
- Additional information
  - Social function (Jensen score (4 being dependent to 1 being independent), mean (SD)): 2.39 (± 1.21)

Intervention group 2 (DHS)

- Age (mean (SD)): 83.7 (± 10.1) years
- Gender (M/F): 22/84
- Mobility assessment (Parker scale from 0 to 9, with 9 being most mobile, mean (SD)): 6.2 (± 2.81)
- Place of residence (own home/nursing home): n = 65/41
- ASA status (I/II/III/IV): 3/30/66/7
- Additional information
  - Social function (Jensen score (4 being dependent to 1 being independent), mean (SD)): 2.33 (± 1.22)

Note: study authors did not report: smoking history, medication, BMI, cognitive status/dementia or preoperative waiting time

Interventions	**General details:** preoperative prophylactic antibiotics; low-molecular-weight heparin followed by Coumadin as prophylactic anticoagulation for 6 weeks; identical rehabilitation protocol, mobilised out of bed on the second day, ambulation with weight bearing on the third or fourth day; clinical follow-up at 3, 6 and 12 months; all surgeons had performed ≥ 8 of each operation before the study **Intervention group 1** • PFN (Synthes-Stratec, Oberdorf, Switzerland); distal locking in all patients; the length of the nail was not reported in the study report but it is probable that all implants were short nails • Randomised = 100; analysed at 12 months = 79 (16 died, 5 lost to follow-up) for pain, ADL, mobility **Intervention group 2** • DHS (Synthes-Stratec, Oberdorf, Switzerland); in almost all cases, the side plate was 135 degrees with 4 holes • Randomised = 106; analysed at 12 months = 89 (13 died, 4 lost to follow-up) for pain, ADL, mobility
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; operative blood loss; mean units transfused; number of patients transfused; radiographic screening time; cut-out; non-union (and time to consolidation); implant failure; reoperation; wound infection; pneumonia; pressure sores; DVT; PE; urinary infection; cardiac failure/infarction; all medical complications; mortality; pain at follow-up; social function; transfer to long-term care; length of follow-up: 12 months **Outcomes relevant to the review:** LOS; discharge destination (categorical: home; or nursing home/rehabilitation hospital); mortality (during hospital stay and 12 months); mobility (Parker and Palmer score; at 12 months); social function (ADL, Jensen, at 12 months); pain (4-point scale: 1 = no pain to 4 = severe, at 12 months); unplanned return to theatre (12 months); complications: deep infection; plate/screw failure (reported as fixation failure); cut-out; intraoperative fracture; non-union; pneumonia; DVT; PE; UTI; blood transfusion; cardiovascular complications (reported in the review with data for MI)
Notes	**Funding/sponsor/declarations of interest:** quote: "No benefits in any form have been received or will be received from a commercial party directly or indirectly to the subject of this article. No funds were received in support of this study" **Study dates:** March 1998 to July 2000 **Notes** • We received additional information from the study authors. • This trial was concurrent with Sadowski 2002, and included a different participant group.

Risk of bias

Saudan 2002 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "No patient refused randomization, which was accomplished with use of computer-generated random numbers."
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote (from direct communication with study authors): "All the surgeons involved in this study had performed an average of eight procedures with the PFN prior to the initiation of the randomized clinical trial."
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most participant loss was because of death, which is expected in this population. Additional loss to follow-up due to participants leaving the country, all clearly reported
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Sharma 2018

Study characteristics	
Methods	Quasi-randomised; parallel design **Review comparison group**: ultra-short PFN versus DHS
Participants	**Total number of randomised participants:** 60 **Inclusion criteria:** cases of stable intertrochanteric fractures in adults > 18 years of age **Exclusion criteria:** cases with marrow cavity blocked by another implant, deformed femur, narrow marrow cavity, pathological facture or old complicated fracture **Setting:** single centre; government secondary-level hospital; Brazil

Sharma 2018 *(Continued)*

Baseline characteristics

Intervention group 1 (intramedullary)

- Age (mean (range)): 60.67 (40 to 80) years
- Gender (M/F): not clearly reported
- Preoperative waiting time (mean): 4.1 days
- Fracture classification: n: 31 A1 (according to inclusion criteria all were stable fractures)

Intervention group 2 (extramedullary)

- Age (mean (range)): 62.27 (44 to 81) years
- Gender (M/F): not clearly reported
- Preoperative waiting time (mean): 4.5 days
- Fracture classification: n: 29 A1 (according to inclusion criteria all were stable fractures)

Note: study authors report no baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status or ASA status

Interventions	**General details:** 1 surgeon operated on all cases; exercises from POD1, early mobilisation with walker as soon as possible with non-weight-bearing, later partial weight-bearing started depending on compliance of participant **Intervention group 1** • Ultra short PFN (Sharma Surgicals, Chandigarh, India); 18 cm length, diameter of proximal part 14 mm, anti-rotation screw of 6.4 mm and hip screw of diameter 8.0 mm; distal locking not reported • Randomised = 31; no losses; analysed = 31 **Intervention group 2** • DHS; 3-hole plate combined with an anti-rotation screw • Randomised = 29; no losses; analysed = 29 **Note:** study authors did not report experience of surgeon, perioperative use of antibiotics of antithromboembolics, type of anaesthesia
Outcomes	**Outcomes measured/reported by study authors:** intraoperative observations (length of incision, radiation exposure, duration of surgery, average blood loss, need for blood transfusion, failure to achieve closed reduction, hospital LOS, duration of full weight bearing); early complications (iatrogenic fracture, technical error, superficial infection, DVT); late complications (loss of reduction, implant failure, second surgery, mean shortening, non union, mal union, deaths); functional outcome (HHS; measured at 1 month, 3 months, 6 months, and 2 years) **Outcomes relevant to the review:** LOS; early complications (iatrogenic fracture, DVT, blood transfusion, intra-operative fracture, superficial infection; within 1 month); late complications (non-union, plate/screw failure (reported as fixation failure), DVT, postoperative fracture, final time point is not reported); mortality (reported as after 3 months, we have assumed final time point of 2 years); functional outcome (HHS; at 3 months and 2 years); unplanned return to theatre (assumed to be up to 24 months) **Notes:** the study authors reported data for LOS and function without distribution values and we did not include these data in meta-analysis; we reported these data in an appendix.
Notes	**Funding/sponsor/declarations of interest:** funding not reported. Study authors declare no conflicts of interest **Study dates:** 2011 to 2015

Risk of bias

Bias	Authors' judgement	Support for judgement

Sharma 2018 *(Continued)*

Random sequence generation (selection bias)	High risk	Quasi-randomised trial. Participants were allocated alternately to each intervention.
Allocation concealment (selection bias)	High risk	Allocation was alternate, with the same surgeon performing all operations. It was not possible to conceal allocation.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors do not decribe whether the surgeon was equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No reported losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Singh 2017

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: PFN versus Locking Compression Plate
Participants	**Total number of randomised participants:** 48 **Inclusion criteria:** people with unilateral, closed unstable trochanteric fractures (31.A2 & 31.A3), > 18 years of age **Exclusion criteria:** bilateral fractures, polytrauma, pathologic fractures, open fractures (ASA status IV or V), associated hip osteoarthritic (Kellgren-Lawrence grade 3 or 4) **Setting:** single centre; hospital; India

Singh 2017 *(Continued)*

	Baseline characteristics **Intervention group 1** (intramedullary) • Age (mean (SD)): 58.3 (± 9.3) years • Gender (M/F): 9/14 • Mobility assessment (independent/assisted/unable): n = 17/6/0 • Preoperative waiting time (mean (SD)): 5.12 (± 2.24) days • Fracture classification (31A2/31A3): n = 14/9 **Intervention group 2** (extramedullary) • Age (mean (SD)): 60.5 (± 8.1) years • Gender (M/F): 7/15 • Mobility assessment (independent/assisted/unable): n = 18/4/0 • Preoperative waiting time (mean (SD)): 6.18 (± 2.42) days • Fracture classification (31A2/31A3): n = 12/10 **Note:** study authors reported no baseline characteristics for: smoking history, medication, BMI, comorbidities, place of residence, cognitive status, ASA status or preoperative waiting times
Interventions	**General details:** before surgery, each patient's standard plain radiographs (1 anteroposterior, 1 lateral) were evaluated. Patients underwent surgery as soon as their general medical condition allowed. Knee and ankle exercises on POD 1. Non-weight-bearing walking with bilateral axillary crutches usually on POD 3 to 5. Progressive weight-bearing started after 6 weeks. **Intervention group 1** • PFN; distal locking and length of nail were not reported in the study report • Randomised = 24; losses = 1 (reason for loss is not reported by group; of the 3 participants that were lost, one was owing to death, and 2 were lost to follow-up because of change in contact details); analysed = 23 **Intervention group 2** • Locking Compression Plate Proximal Femur • Randomised = 24; losses = 2 (reason for loss is not reported by group; of the 3 participants that were lost, one was owing to death, and 2 were lost to follow-up because of change in contact details); analysed = 22 **Note:** study authors did not report number of clinicians (and their skills or experience), type of anaesthesia, use of perioperative antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** perioperative measures: operative time, incision length, radiologic exposure, LOS, blood loss, union rate, time to union, reduction quality. Complications: deep and superficial infections; local site pain; non-union; implant-related breakage, cut-out, or Z-effect; unrelated to fracture (bed sore, chest infection and DVT; revision surgery, shortening. Functional outcome (HHS; at final 2-year follow-up); mobility (Palmer and Parker Mobility score; at final 2 year follow-up) **Outcomes relevant to the review:** LOS; functional outcome (HHS; at final 2 year follow-up); mobility (Palmer and Parker Mobility score; at final 2-year follow-up); implant related (breakage); unplanned return to theatre (at 2 years); complications: superficial infection, loosening, deep infection, non-union **Note:** we did not report data for bed sore, chest infection and DVT because these data were combined in a single outcome.
Notes	**Funding/sponsor/declarations of interest:** funding sources not reported. Study authors report no actual or potential conflicts of interest **Study dates:** April 2009 to June 2011

Singh 2017 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "A sealed envelope method was used to randomly assign 24 of these patients to PFN treatment and the other 24 to PFLCP treatment" Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes, but study authors do not report if envelopes are opaque and sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	There wew losses, which were balanced between groups and some could be explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Singh 2019

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: PFNA versus DHS
Participants	**Total number of randomised participants:** 60 **Inclusion criteria:** elderly patients (> 60 years of age); with stable intertrochanteric fractures (31 A.1 to A2.1); willing to give informed consent

Singh 2019 *(Continued)*

Exclusion criteria: younger patients (< 60 years of age), with pathological fractures; unstable intertrochanteric fractures (31 A2.2 to A3.3); unfit for surgery; polytrauma; previous hip surgery; refusal to participate

Setting: single centre; hospital; India

Baseline characteristics

Intervention group 1 (intramedullary)

- Age (mean (SD)): 72.76 (± 9.5) years
- Gender (M/F): 9/21
- ASA status (I/II/III/IV/V): 20/8/2/0/0
- Fracture classification (31A1.1 to A1.3/31A2.1): n = 22/8

Intervention group 2 (extramedullary)

- Age (mean (SD)): 69.33 (± 5.7) years
- Gender (M/F): 16/14
- ASA status (I/II/III/IV/V): 23/6/1/0/0
- Fracture classification (31A1.1 to A1.3/31A2.1): n = 20/10

Note: study authors reported no baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status or preoperative waiting time

Interventions	**General details:** under supervision of 2 consultant surgeons with adequate skill in using both implants; encouraged to perform exercises on POD1. Weight-bearing with a walker, and physiotherapy support, on POD2 **Intervention group 1** • PFN (DePuy Synthes); distal locking and length of nail were not reported in the study report; the PFNA II utilises a blade for static fixation of the head and neck • Randomised = 24; losses = 1 (reason for loss is not reported by group; of the 3 participants that were lost, one was owing to death, and 2 were lost to follow-up because of change in contact details); analysed = 23 **Intervention group 2** • DHS (DePuy Synthes) • Randomised = 24; losses = 2 (reason for loss is not reported by group; of the 3 participants that were lost, one was owing to death, and 2 were lost to follow-up because of change in contact details); analysed = 22 **Note:** study authors did not report type of anaesthesia, or perioperative use of antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** intraoperative variables (blood loss, fluoroscopy time, duration of surgery); neck shaft angle, Tip Apex distance; functional outcome (modified HHS; SF-12 PCS and MCS); complications (varus collapse; lateral migration of blade/screw; cut out; non-union; implant failure; infection; fracture shaft of femur; reoperation; symptomatic DVT; decubitus ulcer, hyponatremia; AF, pneumonia); mortality **Outcomes relevant to the review:** mortality (6 months); functional outcome (modified HHS at 1 year); HRQoL (SF-12 PCS; at 1 year); unplanned return to theatre; complications: non-union, cut out; superficial infection, postoperative fracture; reoperation, DVT, pneumonia
Notes	**Funding/sponsor/declarations of interest:** funding sources, or declarations of interest not reported **Study dates:** September 2014 to October 2016

Singh 2019 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random number table
Allocation concealment (selection bias)	Low risk	Quote: "By using white opaque envelope technique, allocation concealment was done"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Surgeons were adequately experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study losses were balanced and mostly explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Song 2011

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: Gamma nail versus DHS
Participants	**Total number of randomised participants:** 60 **Inclusion criteria:** elderly patients (> 60 years of age); with stable intertrochanteric fractures (31 A.1 to A2.1); willing to give informed consent

Song 2011 *(Continued)*

	Exclusion criteria: clinical signs of infection; neoplasia; other operative procedures within the previous 3 months; pathological fractures; unstable fractures; perioperative myocardial infarction; inflammatory myopathy **Setting:** single centre; hospital; China **Baseline characteristics** **Intervention group 1** (intramedullary) • Age (mean (SD)): 67.9 (± 7.0) years • Gender (M/F): 6/24 • Fracture classification (31.A1/31.A2): n = 24/6 • Comorbidities (hypertension/diabetes/COPD): n = 8/9/5 • Preoperative waiting time (time from fracture to surgery, mean (SD)): 3.4 (± 1.2) days **Intervention group 2** (extramedullary) • Age (mean (SD)): 68.8 (± 6.7) years • Gender (M/F): 8/22 • Fracture classification (31.A1/31.A2): n = 25/5 • Comorbidities (hypertension/diabetes/COPD): n = 6/7/6 • Preoperative waiting time (time from fracture to surgery, mean (SD)): 3.5 (± 1.2) days **Note:** study authors reported no baseline characteristics for: smoking history, medication, BMI, ASA status, mobility assessment, place of residence or cognitive status
Interventions	**General details:** standard traction table; supine position; performed under an X-ray amplifier; low-molecular-weight heparin calcium injection **Intervention group 1** • Gamma nail (Stryker); distal locking; interlocking of the lag screw 5 mm into the subchondral • Randomised = 30; no losses reported **Intervention group 2** • DHS (DePuy Synthes) • Randomised = 30; no losses reported
Outcomes	**Outcomes measured/reported by study authors:** C-reactive protein levels; creatinine kinase level **Outcomes relevant to the review:** no relevant outcomes
Notes	**Funding/sponsor/declarations of interest:** study authors declare no funding sources and that there were no conflicts of interest **Study dates:** January 2008 and December 2009 **Note:** we did not conduct risk of bias assessment because study reported no review outcomes

Tao 2013

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: PFNA versus reverse LISS

Tao 2013 *(Continued)*

Participants	**Total number of randomised participants:** 100 **Inclusion criteria:** people with intertrochanteric femoral fractures; > 65 years of age **Exclusion criteria:** pathological fractures, osteoarthritis of the hips, ASA status IV or V **Setting:** single centre; hospital; China **Baseline characteristics** **Intervention group 1** (intramedullary) • Age (mean (SD)): 80.4 (± 7.3) years • Gender (M/F): 16/29 • Mobility assessment (independent walking/assisted walking/bedridden): n = 41/3/1 • Preoperative waiting time (mean (SD)): 5.98 (± 3.2) days • Fracture classification (31 A1/31 A2/31 A3): n = 10/21/14 **Intervention group 2** (extramedullary) • Age (mean (SD)): 79.6 (± 7.6) years • Gender (M/F): 17/25 • Mobility assessment (independent walking/assisted walking/bedridden): n = 40/2/0 • Preoperative waiting time (mean (SD)): 6.14 (± 3.9) days • Fracture classification (31 A1/31 A2/31 A3): n = 9/21/12 **Note:** study authors reported no baseline characteristics for: smoking history, medication, BMI, comorbidities, place of residence, cognitive status or ASA status
Interventions	**General details:** 3 orthopaedic consultants (surgeons are familiar with PFNA but not with LISS); prophylactic IV first generation cephalosporin started before surgery and continued up to 48 to 72 hours postoperatively; partial and full weight-bearing allowed on 3rd and 6th postoperative week for PFNA group; partial and full weight bearing on 6th and 12th postoperative week for LISS group **Intervention group 1** • PFNA; no further surgical or implant details reported • Randomised = not reported by group; losses (lost fo follow-up) = not reported by group; analysed = 45 **Intervention group 2** • Reverse LISS (less invasive stabilisation plate); no further surgical or implant details reported • Randomised = not reported by group; losses (lost to follow-up) = not reported by group; analysed = 42 **Note:** study authors did not report whether surgeons were equally experienced with both implants, or type of anaesthesia
Outcomes	**Outcomes measured/reported by study authors:** duration of surgery, fluoroscopy time, blood loss, quality of reduction (open reduction cases), LOS, bone healing time, postoperative walking ability, HHS (pt.), postoperative complications (pressure sore, urinary infection, pulmonary infection, DVT), mortality **Outcomes relevant to the review:** functional status (HHS.pt; we assumed that this was a modified HHS); LOS; mobility (independent walking, assisted walking, bedridden); mortality (12 months); complications: UTI, pneumonia, DVT, non-union **Note:** time points of data are not clearly reported but we assumed these were at the end of follow-up which was 1 year.
Notes	**Funding/sponsor/declarations of interest:** funding or declarations of interest not reported

Tao 2013 *(Continued)*

Study dates: September 2010 to August 2011

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Study authors state that surgeons were familiar with PFNA but not with reverse LISS
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Number randomised to each group and the numbers of losses in each group was not reported and we therefore could not ascertain amount of attrition in the study.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	High risk	We noted a difference in postoperative/rehabilitation management, regarding time at which weight-bearing was allowed in each group.

Utrilla 2005

Study characteristics

Methods	RCT; parallel design **Review comparison group:** TGN versus CHS
Participants	**Total number of randomised participants:** 210 **Inclusion criteria:** trochanteric proximal femoral fractures; ≥ 65 years of age

Utrilla 2005 *(Continued)*

Exclusion criteria: subtrochanteric fractures; pathologic fractures; history of a previous lower limb injury; severe concomitant medical condition (ASA score of V)

Setting: single centre; orthopaedic hospital; Spain

Baseline characteristics (overall)

- Age (mean (range)): 80 (65 to 104) years
- Gender (M/F): 68/144
- Place of residence (own home): n = 203
- Mobility assessment (walk without aids): n = 132

Intervention group 1 (TGN)

- Age (mean (SD)): 80.6 (± 7.5) years
- Gender (M/F): 38/66
- Mobility assessment (mobility score (0–9 points, where 9 equates to maximum mobility; Parker 1993), mean (SD)): 7.7 (± 1.8)
- Place of residence (own home/institution): n = 98/6
- Cognitive status (mental test score (0–10 points, where 10 equates to good cognitive status; Qureshi 1974), mean (SD)): 9.4 (± 1.4)
- ASA status (I/II/III/IV): 13/39/41/11
- Fracture classification (stable/unstable): n = 81/23

Intervention group 2 (CHS)

- Age (mean (SD)): 79.8 (± 7.3) years
- Gender (M/F): 28/78
- Mobility assessment (mobility score, mean (SD)): 7.4 (± 1.9)
- Place of residence (own home/institution): n = 105/1
- Cognitive status (mental test score (0–10 points, where 10 equates to good cognitive status; Qureshi 1974), mean (SD)): 9.3 (± 1.9)
- ASA status (I/II/III/IV): 14/35/54/3
- Fracture classification (stable/unstable): n = 75/31

Note: study authors did not report: smoking history, medication, BMI, cognitive status/dementia or preoperative waiting time

Interventions	**General details:** Fracture fixation was performed within 4 days; 4 surgeons experienced Gamma nails; first 3 TGN operations performed by each surgeon were not included in the study and served as the learning curve; spinal anaesthesia (all but 3 patients); traction table with fluoroscopic control; suction drains for 48 hours; antibiotic and thromboembolic prophylaxis; clinical examination at 1, 3, 6, and 12 months **Intervention group 1** • TGN (Stryker Howmedica); implant length 180 mm; proximal and distal diameters of 17 mm and 11 mm; neck shaft angle 130; distal locking was performed with a single screw for rotationally unstable fractures • Randomised = 104; 3 lost at 12 months; 19 died; analysed for all 12 month outcomes = 82 **Intervention group 2** • CHS (Stryker Howmedica) • Randomised = 106; 4 lost at 12 months; 21 died; analysed for all 12 month outcomes = 81
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood transfusion; radiographic screening time; operative fracture of the femur; later fracture of the femur; cut-out of implant; reoperation; deep wound sepsis; local wound healing complications; DVT; shortening; hip flexion; mobility; pain (hip and thigh pain); mortality (available at 1, 3, 6 and 12 months); length of follow-up: 12 months

Utrilla 2005 *(Continued)*

	Outcomes relevant to the review: mortality (at 3 months and at 12 months); unplanned return to theatre (12 months); mobility; pain (hip pain at 12 months); complications: blood transfusions; DVT; superficial infection; deep infection; intra-operative fracture; postoperative fracture; screw/plate failure (reported as fixation failure); cut-out; all at 12 months **Note:** study authors reported pain in the hip and the thigh region. In analysis, we included only data for hip pain.
Notes	**Funding/sponsor/declarations of interest:** quote: "No financial support of this project occurred. None of the authors received anything of value" **Study dates:** October 1998 through December 2000

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "The patients were randomized for treatment into 2 groups based on sequence of admission, sealed envelopes were opened before the surgeon attempted a closed reduction of the fracture." Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	Study authors do not report whether envelopes are opaque and sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote: "Four surgeons experienced in the standard Gamma nail did all the operations; however, the first 3 TGN operations performed by the surgeons were not included in the study and served as the learning curve for the new instrumentation."
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were balanced between groups and were mostly explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Varela-Egocheaga 2009

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** Gamma nail versus PCCP

Participants	**Total number of randomised participants:** 80
	
	Inclusion criteria: > 60 years; stable intertrochanteric fracture (AO/OTA 31.A1–31.A2.1)
	
	Exclusion criteria: open reduction; reverse obliquity fractures (AO/OTA 31.A3); unstable intertrochanteric fractures; pathological fracture; presence of metastatic malignant disease; ipsilateral lower limb surgery; contra-lateral hip fracture within the past 12 months
	
	Setting: single centre; orthopaedic hospital; Spain
	
	Baseline characteristics
	
	Intervention group 1 (Gamma 3)
	
	• Age (mean): 82.5 years
	• Gender (M/F): 6/34
	• Comorbidities (n)
	  ◦ Arterial hypertension: 9
	  ◦ Diabetes: 6
	  ◦ Dementia senile: 5
	  ◦ Transient ischaemic accident: 4
	  ◦ Parkinsons: 0
	  ◦ Contralateral fracture of the hip: 2
	• Mobility assessment/use of walking aides (without help/cane/walker): n = 15/20/5
	• ASA status (I/II/III/IV): 0/12/18/2; 8 no class
	• Fracture types (AO/ASIF): n
	  ◦ 31 A1.1: 10
	  ◦ 31 A1.2: 16
	  ◦ 31 A1.3: 1
	  ◦ 31 A2.1: 7
	  ◦ 31 A2.2: 5
	  ◦ 31 A2.3: 1
	• Additional information
	  ◦ 1 high-energy fall
	
	Intervention group 2 (PCCP)
	
	• Age (mean): 81.6 years
	• Gender (M/F): 11/29
	• Comorbidities (n)
	  ◦ Arterial hypertension: 16
	  ◦ Diabetes: 4
	  ◦ Dementia senile: 3
	  ◦ Transient ischemic accident: 3
	  ◦ Parkinsons: 2
	  ◦ Contralateral fracture of the hip: 3
	• Mobility assessment/use of walking aides (without help/cane/walker): n = 18/15/7
	• ASA status (I/II/III/IV): 0/10/15/5; 10 no class

Varela-Egocheaga 2009 *(Continued)*

- Fracture types (AO/ASIF): n
  - 31 A1.1: 15
  - 31 A1.2: 7
  - 31 A1.3: 2
  - 31 A2.1: 11
  - 31 A2.2: 4
  - 31 A2.3: 1
- Additional information
  - 2 high-energy fall

Note: study authors did not report: smoking history, medication, BMI, place of residence, cognitive status/dementia or preoperative waiting time

Interventions	**General details:** fracture table; immediate postoperative full-weight bearing; prophylactic antibiotics and prophylactic low-molecular-weight heparin (6 weeks postoperatively); 1 year period prior to study as 'learning curve' period for surgeons **Intervention group 1** • Gamma 3 nail (Stryker); nail length was not reported but it is highly probable that all nails were short; the cephalic screw was locked dynamically; distal locking was performed in all cases and was either static or dynamic • Randomised = 40; loss to follow-up not reported **Intervention group 2** • PCCP; two dynamic neck screws and three plate-shaft screws • Randomised = 40; loss to follow-up not reported
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood transfusion; fall in haemoglobin; cut-out of implant; confusion; stroke; congestive cardiac failure; pneumonia; genitourinary infection; LOS; mortality; discharge to intermediate care; postoperative analgesia (duration and dose of Metamizol); failure to regain mobility; length of follow-up: 12 months **Outcomes relevant to the review:** LOS; discharge destination (own home, intermediate hospital); mobility (12 months); mortality (during hospital stay and 12 months); functional status (independent walking, cane, walker, no walking; 12 months); complications: cut-out; disorientation/delirium; UTI; cerebrovascular accident; pneumonia; cardiac failure; all outcomes at 12 months
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** June 2006 and March 2007

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "randomized using a table of randomized numbers"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.

Varela-Egocheaga 2009 *(Continued)*

Other performance bias: surgeon experience of both implants	Low risk	Study authors described prior 'learning curve' period before start of the trial, and we judged that surgeons were therefore likely to have experience with both implants
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few losses, which were balanced between groups
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Verettas 2010

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** Intramedullary nail versus DHS

Participants	**Total number of randomised participants:** 120
	
	Inclusion criteria: unstable trochanteric proximal femoral fractures (AO/OTA type 31-A2 and Evans type III or IV); >70 years of age; walk independently with or without aid; low-energy injury within 24 hours of admission
	
	Exclusion criteria: rheumatoid arthritis; pathological fracture
	
	Setting: single centre; orthopaedic hospital; Greece
	
	Baseline characteristics
	
	Intervention group 1 (Intramedullary nail)
	
	• Age (mean (SD)): 79.22 (± 7.99) years
	• Gender (M/F): 20/40
	• Comorbidities (Ceder C): n = 55
	  ◦ None: 4
	  ◦ One: 14
	  ◦ Two: 18
	  ◦ More than two: 23

Verettas 2010 *(Continued)*

- ASA status (mean (SD)): 1.9 (± 0.6)
- Additional information
  - ADL Katz scale: 7.7 (± 1.8)

Intervention group 2 (DHS)

- Age (mean (SD)): 81.03 (± 6.38) years
- Gender (M/F): 15/45
- Comorbidities (Ceder C): n = 51
  - None: 8
  - One: 10
  - Two: 26
  - More than two: 15
- ASA status (mean (SD)): 1.8 (± 0.6)
- Additional information
  - ADL Katz scale: 7.6 (± 1.9)

Note: study authors did not report: smoking history, medication, BMI, place of residence, cognitive status/dementia, preoperative waiting time or mobility

Interventions	**General details:** operated as soon as possible after their admission and in no case later than 24 hours; general parenteral opiate or spinal analgesia dependent of the anaesthetist's assessment; reduced by closed methods; prophylactic antibiotics (cephalosporin) for 48 hours; prophylactic low-molecular-weight heparin for a total of 3 weeks; postoperative analgesia included a non-steroid anti-inflammatory medication; surgeons had previous experience of the use of these implants **Intervention group 1** • Gamma nail (n = 38) (Stryker) or Endovis BA nail (n = 22) (Citieffe, Bologna, Italy); in the case of the Gamma nail proximal locking is performed with a single screw whereas the Endovis BA nail utilises 2 cephalic screws; details of distal locking and length of nails was not reported in the study report however it is highly probable that all nails were short • Randomised = 60; 1 lost to follow-up due to death; analysed for all outcomes = 59 **Intervention group 2** • DHS (Synthes) • Randomised = 60; 1 lost to follow-up due to death; analysed for all outcomes = 59
Outcomes	**Outcomes measured/reported by study authors:** length of surgery; blood loss; radiographic screening time; number of patients transfused; superficial wound infection; DVT ("immediate post-operative"); cardiovascular complication ("immediate post-operative"); neurologic complication/ delirium ("immediate post-operative"); respiratory complication ("immediate post-operative"); haematocrit; oxygen saturation and pressure; mental test score; LOS; days to being able to walk with a walker; mortality (in hospital); pain score; length of follow-up: duration of hospital stay (mean 10 days) **Outcomes relevant to the review:** mortality (during hospital stay); pain (VAS, 6 to 10 days); LOS; complications: intraoperative fracture; DVT; superficial infection; blood transfusion; unless stated the time point is assumed to be during hospital stay as no further follow-up is reported **Note:** study authors reported data for LOS without SD and we did not include these data in meta-analysis; we reported these data in an appendix.
Notes	**Funding/sponsor/declarations of interest:** funding not reported; study authors declare no conflicts of interests **Study dates:** not reported **Note:** study author explained that the change in intramedullary nail was the result of a supplies policy at the hospital

Verettas 2010 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "The patients were allocated to each group alternatively on their admission."
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation with this method of randomisation.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Quote: "In our study the operating time was similar in both groups, possibly because the surgeons had previous experience of the use of these implants." However, there was a change in the type of nail used during the study period, and we could not be certain whether all surgeons were equally experienced with the newer implant.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few study losses which are explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Wang 2019

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: PFNA versus DHS
Participants	**Total number of randomised participants:** 114

Wang 2019 *(Continued)*

	Inclusion criteria: diagnosed with intertrochanteric fractures on X-ray; no cardiac accidents before admission; no cognitive disorder; preoperative BP and blood sugar (and other common diseases) controlled in a normal state **Exclusion criteria:** severe cardiovascular and cerebrovascular disease; combined with other fractures; pathological fracture; mental illness before fracture; surgical contraindications **Setting:** hospital; single centre; China **Baseline characteristics (overall)** • Age (mean (SD)): 73.16 (± 3.47) years • Gender (M/F): 43/71 • Comorbidities (hypertension/diabetes): n = 50/41 • Preoperative waiting time (mean (SD)): 4.18 (± 0.72) days • Fracture classification (Evans-Jensen type 1/type II/type III/type IV): n = 33/32/32/8. All closed fractures **Note:** study author only reported overall baseline characteristics. No data reported for: smoking history, medication, BMI, mobility assessment, place of residence; cognitive status or ASA status
Interventions	**General details:** all given antibiotics; epidural anaesthesia; on POD 2, allowed to sit, half-squat, sit up, turn over, and perform contractile function exercise of active and passive muscle, as well as knee flexion and extension exercises **Intervention group 1** • PFNA; proximal locking was performed using a spiral blade which was locked statically; distal locking was performed through an aiming arm; although the study report did not specifically report the length of nails it is highly probable that all were short nails • Randomised = 57; no losses **Intervention group 2** • DHS • Randomised = 57; no losses
Outcomes	**Outcomes measured/reported by study authors:** operation time; volume of intraoperative blood loss; postoperative drainage volume; weight-bearing time: serum inflammatory markers; serum levels of MI markers and heart failure markers **Outcomes relevant to the review:** none
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** January 2016 to February 2018 **Note:** we did not conduct risk of bias assessment because study reported no review outcomes

Xu 2010

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFNA versus DHS
Participants	**Total number of randomised participants:** 106

Xu 2010 *(Continued)*

	Inclusion criteria: unstable proximal femoral fracture (AO category 31-A2) **Exclusion criteria:** < 65 years of age; pathological fractures; fractures associated with polytrauma; previous surgery on the ipsilateral hip or femur; inability to work before injury; severe concomitant medical condition (ASA status V) **Setting:** single centre; orthopaedic hospital; China **Intervention group 1** (PFNA) • Age (mean (SD)): 78.5 (± 7.97) years • Gender (M/F): 15/36 • Mobility score (Parker scale (Parker 1993), mean (SD)): 6.71 (± 1.89) • ASA status (I/II/III/IV): 12/22/10/7 **Intervention group 2** (DHS) • Age (mean (SD)): 77.9 (± 7.82) years • Gender (M/F): 16/39 • Mobility score (Parker scale (Parker 1993), mean (SD)): 6.18 (± 1.83) • ASA status (I/II/III/IV): 14/21/11/9 **Note:** study authors did not report: smoking history, medication, BMI, comorbidities, place of residence, cognitive status/dementia or preoperative waiting time
Interventions	**General details:** performed through an open approach with direct exposure of the fracture; all operations were performed by surgeons who had performed ≥ 3 procedures with both the interventions; preoperative ceftriaxone (2 g); general or spinal anaesthesia; prophylactic antibiotics for 3 to 5 days; movement of hip, knee and ankle joints on the first postoperative day; continuous passive motion rehabilitation devices used twice daily; clinical examination at 1, 3, 6 and 12 months **Intervention group 1** • PFNA; solid titanium nail 170 mm or 240 mm in length and 10 mm or 11 mm in diameter; spiral blade for cephalic fixation. Configuration of distal locking for the nail group was not clearly reported • Randomised = 51; 3 months: 2 lost to follow-up, 1 died; 12 months: 4 lost to follow-up, 2 died, 2 excluded; analysed for mortality = 51; analysed for complications = 51; analysed for mobility = 48 (at 3 months) and 40 (at 12 months) **Intervention group 2** • DHS; 3 or 4 holes and a 135° plate with a screw of appropriate • Randomised = 55; 3 months: 2 lost to follow-up, 2 died, 1 excluded; 12 months: 3 lost to follow-up, 3 died, 1 excluded; analysed for mortality = 55; analysed for complications = 55; analysed for mobility = 50 (at 3 months) and 43 (at 12 months)
Outcomes	**Outcomes measured/reported by study authors:** mortality (at 3 and 12 months); operation time; fluoroscopy time; blood loss; blood transfusion; cut-out; union; fixation failure; wound infection; lower respiratory tract infection; decubital ulcer; UTI; cerebral infarction; LOS; mobility score (Parker scale at 3 and 12 months); time to mobilise with frame; time to achieve preoperative mobility; return to preoperative mobility at 12 months; shortening of the femur on radiograph at 12 months **Outcomes relevant to the review:** mobility score (Parker scale at 3 and 12 months); mortality (at 3 and 12 months); LOS; unplanned return to theatre (12 months); complications: cut-out; blood transfusion; non-union; plate/screw failure (reported as fixation failure); superficial infection; chest infection; PE; UTI; cerebral infarction; femoral fracture (intra- and postoperative); all at 12 month follow-up
Notes	**Funding/sponsor/declarations of interest:** funding not reported, authors declare no conflicts of interest **Study dates:** August 2006 and June 2008

Xu 2010 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: “consecutive numbered and sealed envelopes based on a computer generated list”
Allocation concealment (selection bias)	Unclear risk	Quote: “sealed envelopes were opened before the surgeon performed the operation” Comment: study authors do not report whether envelopes are opaque or sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Low risk	Quote: “All operations were performed by surgeons who had performed at least three procedures with both the PFNA and the DHS”
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study losses were balanced between groups, and mostly explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Xu 2018

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: PFNA versus DHS
Participants	**Total number of randomised participants:** 100

Xu 2018 *(Continued)*

Inclusion criteria: ≥ 65 years of age; femoral neck bone density score < -2.5 standard deviations; primary femoral intertrochanteric fracture

Exclusion criteria: femoral head necrosis; Evans type II fracture or other serious complications detected in imaging examinations; surgical indications

Setting: hospital; single centre; China

Baseline characteristics

Intervention group 1 (intramedullary)

- Age (mean (SD)): 68.2 (± 7.4) years
- Gender (M/F): 23/27
- Comorbidities (complications (not defined)): n = 33
- Fracture classification (Evans type Ia/Ib/Ic/Id): n =13/16/14/7

Intervention group 2 (extramedullary)

- Age (mean (SD)): 70.3 (± 6.2) years
- Gender (M/F): 22/28
- Comorbidities (complications (not defined)): n = 33
- Fracture classification (Evans type Ia/Ib/Ic/Id): n = 15/14/16/5

Note: study authors reported no baseline characteristics for: smoking history, medication history, BMI, mobility assessment, place of residence; cognitive status, ASA status or preoperative waiting time

Interventions	**General details:** prophylactic preoperative antibiotics; prophylactic anti-inflammatory therapy, subcutaneous injection of low-molecular-weight heparin calcium, and anti-osteoporosis drugs. Lower limb muscle contraction exercises on POD 1. Time of weight-bearing was determined according to X-ray examinations (1, 4, 6, and 12 weeks after surgery) **Intervention group 1** • PFNA; the length of nails used was not reported in the study report however it is highly probable that all nails were short nails; details regarding proximal and distal locking of the nails were not reported • Randomised = 50; no losses; analysed = 50 **Intervention group 2** • DHS • Randomised = 50; no losses; analysed = 50
Outcomes	**Outcomes measured/reported by study authors:** operation time, LOS, volume of blood loss, time to postoperative weight-bearing, callusing time, swelling reduction time, TGF-beta2 expression; hip function scores; complications (hip varus, femoral shaft fracture, cut-out of femoral head, fracture site infection, internal fixation breakage) **Outcomes relevant to the review:** LOS; function (HHS; excellent, good, fair, poor; measured at 3 months); complications: postoperative fracture, cut-out, superficial infection; plate/screw failure (reported as internal fixation breakage) (all at 3 months)
Notes	**Funding/sponsor/declarations of interest:** supported by the Research Project of the Jiangsu Health and Family Planning Commission; study authors declare no competing interests **Study dates:** January 2016 to January 2017

Risk of bias

Bias	Authors' judgement	Support for judgement

Xu 2018 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Quote: "patients were randomly divided into two groups" Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Yamauchi 2014

Study characteristics	
Methods	Quasi-randomised; parallel design **Review comparison group**: extra small PFN versus DHS
Participants	**Total number of randomised participants:** 19 **Inclusion criteria:** simple intertrochanteric fractures, 31-A1.1 and A1.2. All patients selected for this study reported walking independently without the use of walking aids such as walking frames or canes before sustaining their initial fracture (i.e. they had equivalent ADL). **Exclusion criteria:** simple fractures such as femoral basal neck fracture, minor trochanter as fracture fragment, comminuted greater trochanteric fractures; pathological fractures, high-energy injuries, or other multiple injuries. Participants with apparent dementia or other psychological problems and se-

Yamauchi 2014 *(Continued)*

	vere perioperative or postoperative complications that would result in delayed postoperative rehabilitation **Setting:** single centre; hospital; Japan **Baseline characteristics** **Intervention group 1** (intramedullary; baseline data for only 10 participants) • Age (mean (range)): 79.7 (70 to 90) years • Gender (M/F): 4/6 • BMI (mean (SD)): 21.38 (± 3.80) kg/m^2 • Mobility assessment: all walking independently without any aids before injury • Cognitive status/dementia: none had dementia or cognitive impairment • Preoperative waiting time (mean (SD)): 5.60 (± 2.41) days • Fracture classification: all 31 A1.1 and A1.2 **Intervention group 2** (extramedullary; baseline data for only 8 participants) • Age (mean (range)): 73.75 (65 to 89) years • Gender (M/F): 2/6 • BMI (mean (SD)): 21.06 (± 2.74) kg/m^2 • Mobility assessment: all walking independently without any aids before injury • Cognitive status/dementia: none had dementia or cognitive impairment • Preoperative waiting time (mean (SD)): 5.25 (± 2.19) days • Fracture classification: all 31 A1.1 and A1.2 **Note:** study authors reported no baseline data for: smoking history, medication, comorbidities, place of residence or ASA status
Interventions	**General details:** a physiotherapist supervised full weight-bearing and walking exercises that were performed on POD 1. Plain anteroposterior and lateral radiographs were also obtained for each patient to confirm complete union of the bone. **Intervention group 1** • PFN; short nails were used in all cases; distal locking was performed with a single screw • Randomised = 10; no losses; analysed = 10 **Intervention group 2** • DHS; plate fixation was performed with two screws • Randomised = 9; losses = 1 (had postoperative delirium and developed dementia); analysed = 8 **Note:** study authors do not report number of surgeons (or their skills or experience), type of anaesthesia, perioperative use of antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** surgical variables (duration of surgery, intraoperative blood loss, haemoglobin). Pain and ADL scores (measured at 1, 2, 3, and 4 weeks after surgery), active ROM, angle of hip flexion, and abduction, time to achieve straight leg raise, time to achieve independent standing on the surgical leg **Outcomes relevant to the review:** pain and ADL (assessed using Japanese Orthopaedic Association (JOA) hip functional scores; at 4 weeks); blood transfusion
Notes	**Funding/sponsor/declarations of interest:** no funding. Study authors declared no conflicts of interest **Study dates:** 2009 to 2012
Risk of bias	

Yamauchi 2014 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quasi-randomised; use of an alternating sequence
Allocation concealment (selection bias)	High risk	It was not possible to blind surgeons to allocation because an alternating sequence was used.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type of implant could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Only one participant was excluded from analysis.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Zehir 2015

Study characteristics	
Methods	RCT; parallel design **Review comparison group**: PFNA versus DHS
Participants	**Total number of randomised participants:** 198 **Inclusion criteria:** unstable trochanteric fractures (31 A2), > 65 years of age **Exclusion criteria:** multiple ipsilateral or contralateral fragmented or pathological fractures, intracapsular fractures, stable fractures; unable to walk or bedridden or wheelchair bound; history of previous hip surgery at either side **Setting:** single centre; tertiary university hospital; Turkey **Baseline characteristics** **Intervention group 1** (PFNA)

Zehir 2015 *(Continued)*

- Age (mean (SD)): 77.22 (± 6.82) years
- Gender (M/F): 37/59
- Comorbidities (diabetes/hypertension/chronic pulmonary disease/heart failure/CAD/multiple disease): n = 8/18/6/12/1/23
- Mobility assessment/use of walking aids: all able to walk prior to injury
- ASA status (I/II/III/IV/V): 0/14/39/43/0
- Preoperative waiting time (mean (SD)): 3.29 (± 1.8) weeks
- Fracture classification (A2.1/A2.2/A2.3): n = 26/41/29

Intervention group 2 (DHS)

- Age (mean (SD)): 76.86 (± 6.74) years
- Gender (M/F): 39/63
- Comorbidities (diabetes/hypertension/chronic pulmonary disease/heart failure/CAD/multiple disease): n = 7/22/3/7/5/22
- Mobility assessment/use of walking aids: all able to walk prior to injury
- ASA status (I/II/III/IV/V): 0/14/54/34/0
- Preoperative waiting time (mean (SD)): 3.35 (± 2.0) weeks
- Fracture classification (A2.1/A2.2/A2.3): n = 23/46/33

Note: study authors report no baseline characteristics for: smoking history, medication, BMI, place of residence or cognitive status

Interventions

General details: 1 of 2 surgeons experienced in hip surgery; prophylactic antibiotics; under spinal, epidural, general anaesthesia, or regional; all participants mobilised out of bed and allowed weight-bearing on POD 1 or POD 2

Intervention group 1

- PFNA (Synthes-Stratec); nail length from 200 mm to 240 mm; diameter 9 mm or 10 mm; cephalic fixation was performed with a spiral blade
- Randomised = 96; no losses (except for death); analysed for LOS = 93; analysed for other outcomes = 96

Intervention group 2

- DHS (Synthes-Stratec); including 25 mm or 38 mm barrels and 3 to 12 holes within the shaft; shaft length ranged from 62 mm to 206 mm
- Randomised = 102; no losses (except for death); analysed = 102

Note: details regarding distal locking were not reported for the nail

Outcomes

Outcomes measured/reported by study authors: length of surgery; fluoroscopy times, volume of blood loss, mortality (in hospital, and at end of follow-up); LOS; superficial infection; deep infection; haematoma; cut-out; screw migration; pain (hip and thigh); reoperation; DVT; PE; decompensated heart failure; UTI; pneumonia; pressure ulcer; time to healing; recovery of walking ability and independent mobility; discharged to home; mean tip-apex distance

Outcomes relevant to the review: mortality (in-hospital and at end of follow-up, median follow-up is 15.95); discharge destination (own home; we can infer this data from the data reported for mortality at end of follow-up); LOS; pain (assumed to be < 4 months); mobility (independent walking, at 12 months); unplanned return to theatre (12 months); complications: superficial wound infection and deep wound infection, cut-out, PE, DVT, UTI, pneumonia (all at 12 months)

Note: study authors reported pain in the hip and thigh region. In the analysis, we included data for hip pain.

Notes

Funding/sponsor/declarations of interest: funding not reported. Study authors declared no conflicts of interest

Zehir 2015 *(Continued)*

Study dates: January 2010 and March 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Using a computer-based random number generator, patients were randomly allocated"
Allocation concealment (selection bias)	Unclear risk	Although sealed envelopes were used, the study authors do not report if the envelopes were opaque or sequentially numbered.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	Experienced hip surgeons, but study authors do not report if surgeons are experienced with using both types of implants in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	Clinically-reported subjective measures were assessed by independent radiographers. However, we assume that no attempts were made to conceal types of interventions, in which case there is a lack of blinding for these subjective measures.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study losses were explained by death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Zhou 2012

Study characteristics

Methods	RCT; parallel design **Review comparison group:** PNFA versus LISS
Participants	**Total number of randomised participants:** 68 **Inclusion criteria:** OTA Type 31A proximal femoral fracture; closed fractures; treated within 3 weeks of injury

Zhou 2012 *(Continued)*

Exclusion criteria: open fractures; pathologic fractures; delayed fractures; multiple fractures; periprosthetic fractures;

Setting: single centre; Orthopaedic Hospital; China

Baseline characteristics

Intervention group 1 (PFNA)

- Age (mean (range)): 76.19 (42 to 103) years
- Gender (M/F): 17/19
- ASA status (I/II/III/IV): 1/21/14/0
- Fracture classification, OTA group (n)
  - 31A1.1: 3
  - 31A1.2: 3
  - 31A1.3: 2
  - 31A2.1: 7
  - 31A2.2: 11
  - 31A2.3: 10
  - 31A3.1: 0
  - 31A3.2: 0
  - 31A3.3: 0

Intervention group 2 (LISS)

- Age (mean (range)): 67.75 (24 to 87) years
- Gender (M/F): 13/15
- ASA status (I/II/III/IV): 2/15/10/1
- Fracture classification, OTA group (n)
  - 31A1.1: 2
  - 31A1.2: 1
  - 31A1.3: 0
  - 31A2.1: 4
  - 31A2.2: 6
  - 31A2.3: 8
  - 31A3.1: 2
  - 31A3.2: 4
  - 31A3.3: 1

Note: study authors did not report: smoking history, medication, BMI, comorbidities, mobility assessment/use of walking aides, place of residence, cognitive status/dementia or preoperative waiting time

Interventions

General details: fracture table and image intensifier were used; performed by 3 senior surgeons; preoperative intravenous antibiotics with 1.5 g cefuroxine; spinal or general anaesthesia; low-molecular heparin was used as thromboembolic prophylaxis for 5 days; postoperative prophylactic antibiotics (1.5 g cefuroxine, 3 doses); weight-bearing dependent on radiographs and partial healing; clinical examination at 1, 3, 6, and 12 months

Intervention group 1

- PFNA (Synthes); nail diameter 12 mm; cephalic fixation was performed using the helical blade. Nail lengths were not reported but it is highly probable that all nails used in the study were short nails; details regarding distal locking of the nails were not reported
- Randomised = 40; 4 excluded after randomisation (because surgeon thought a nail should not be used with Type A3 fracture); analysed for mortality and complications = 36; analysed for function (HHS) is unclear

Intervention group 2

Zhou 2012 *(Continued)*

- LISS (Synthes); the plates were secured with three or four screws in the proximally and four screws in the femoral shaft
- Randomised = 28; 1 lost to follow-up; analysed for mortality and complications = 28; analysed for function (HHS) is unclear

Note: some discrepancies between text and tables in the study report. For mortality, we used data for deaths as reported in the table of the study report.

Outcomes	**Outcomes measured/reported by study authors:** postoperative complications; unplanned return to theatre; intraoperative time; intraoperative blood loss; LOS; hip function (HHS); radiograph evaluation; length of follow up: mean 26.8 months (range 21 to 36 months) **Outcomes relevant to the review:** mortality (at 1 months and 6 months); unplanned return to theatre; LOS; function (HHS; 26.8 months); complications: intra-operative fracture, postoperative fracture, superficial and deep infection; non-union, DVT; acute coronary syndrome; pneumonia; CVA; plate/screw failure (reported as screw breakage or penetration) all at final flow-up of 26.8 months or time of event **Note:** study authors reported data for LOS without SD and we did not include these data in meta-analysis; we reported these data in an appendix
Notes	**Funding/sponsor/declarations of interest:** quote: "no financial support was received for the work on this project" **Study dates:** December 2006 to March 2008

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: “the patients were randomised by a computer generated list”
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	High risk	Quotes: “Surgery was performed by three senior surgeons” and “The longer operative time in the LISS group compared with the PFNA group in the study may be the result of the learning curve" Comment: we judged that surgeons were not equally experienced with both implants
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the intervention could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	We did not expect that lack of blinding of outcome assessors would influence objective outcome data.

Zhou 2012 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Data were reported for all outcomes. We noted some discrepancies between text and tables in the study report, but these were for a small number of participants and we did not expect that they would influence the data.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Zou 2009

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** PFNA versus DHS
Participants	**Total number of randomised participants:** 121 **Inclusion criteria:** low-energy trochanteric proximal femoral fractures **Exclusion criteria:** pathological fracture or multiple injuries **Setting:** single centre; orthopaedic hospital; China **Baseline characteristics** **Intervention group 1** (PFNA) • Age (mean (range)): 65 (37 to 91) years • Gender (M/F): 12/46 • Fracture classification (described as 31-A1 stable/31-A2 or 31-A3 unstable): n = 42/16 **Intervention group 2** (DHS) • Age (mean (range)): 65 (34 to 89) years • Gender (M/F): 15/48 • Fracture classification (described as 31-A1 stable/31-A2 or 31-A3 unstable): n = 52/11 **Note:** study authors did not report: smoking history, medication, BMI, comorbidities, mobility assessment/use of walking aides, place of residence, cognitive status/dementia or preoperative waiting time
Interventions	**General details:** supine position on a fracture table; patients were mobilised and given standard rehabilitation instructions; prophylactic intravenous antibiotic; clinical examinations at 6 weeks and 3, 6 and 9 months, and then annually; no details on surgeons experience **Intervention group 1** • PFNA; nail lengths 170 mm, 200 mm or 240 mm; nail diameter 10 mm, 11 mm or 12 mm; cephalic fixation was performed with the helical blade. Details regarding distal locking of nails were not reported in the study report. • Randomised = 58; no reported loss to follow up, analysed for all outcomes = 58 **Intervention group 2** • DHS; no further details on implant types • Randomised = 63; no reported loss to follow-up, analysed for all outcomes = 63

Zou 2009 *(Continued)*

Outcomes	**Outcomes measured/reported by study authors:** functional outcome at 12 months using the Salvati and Wilson (Salvati 1973) scoring system: categorised as excellent (≥ 32), good (24 to 31), fair (16 to 23) or poor (≤ 15); length of surgery; operative blood loss; radiographic screening time; cut-out of the implant; fracture; non-union; implant breakage; reoperation; superficial and deep wound infection; DVT; LOS; time point unclear, assumed to be 12 months unless reporting operative data **Outcomes relevant to the review:** functional status (Salvati and Wilson; at 12 months); LOS; complications: superficial and deep infection; fracture, plate/screw failure (reported as breakage of implant); cut-out; postoperative fracture; unplanned return to theatre; DVT; time point for adverse events is not clear, assumed to be 12 months **Note:** we did not include LOS data in the review because they were not clearly reported.
Notes	**Funding/sponsor/declarations of interest:** funding not reported; study authors declared no conflicts of interest **Study dates:** January 2006 and December 2007

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to the type of intervention. We did not, however, expect that this would influence surgeons' performance.
Other performance bias: surgeon experience of both implants	Unclear risk	The study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) Clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the intervention could influence judgements made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Low risk	Three independent observers examined participants during assessment of function.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report registration with a clinical trials register or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

2MWT: two-minute walk test; **ADL**: activities of daily living; **AO/OTA:** Association For Osteosynthesis-Orthopaedic Trauma Association; **AP:** Asian-Pacific; **ASA**: American Society of Anesthesiologists; **BMI**: body mass index; **BP:** blood pressure; **CHS**: compression hip screw; **CLD:** chronic liver disease; **CRF:** chronic renal failure; **CVA**: cerebrovascular accident; **DCS:** dynamic condylar screw; **DHS**: dynamic hip screw; **DVT**: deep vein thrombosis; **ECG:** electrocardiogram; **EQ-5D**: European quality of life - 5 dimensions; **EPFN**: expandable proximal femoral nail; **FIM**: functional independence measure; **FRS**: functional recovery score; **g**: gram; **HHS**: Harris Hip Score; **HRQoL**: health-related quality of life; **IM**: intramedullary; **IMHS**: intramedullary hip screw; **IV:** intravenous(ly); **LEM**: lower extremity measure; **LISS:** Less Invasive Stabilization System;**LOS**: length of hospital stay;**MI**: myocardial infarction; **MMSE**: Mini–Mental State Examination; **MMTS**: mean mental test score; **NR**: not reported; **PCCP**: percutaneous compression plate; **PE**: pulmonary embolism; **PFN**: proximal femoral nail; **PFNA**: proximal femoral nail antirotation; **POD:** postoperative day; **RCT**: randomised controlled trial; **ROM:** range of motion; **SD**: standard deviation; **SEM:** standard error of the mean; **SF-12 (PCS/MCS)**: short form - 12 domains (physical component score/mental component score); **SHS**: sliding hip screw; **SPMSQ**: short portable mental status questionnaire; **THA:** total hip arthroplasty; **TIA**: transient ischaemic attack; **TGN**: Trochanteric Gamma nail; **TUG**: Timed Up and Go test; **UTI**: urinary tract infection; **VAS**: visual analogue scale

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
ACTRN12608000162314	Study comparing Gamma nail versus DHS. We received communication from the study contact (Rob Molnar; on 3 August 2015) to explain that the study was abandoned early because of poor recruitment. We excluded this study because no outcome data are available
Ahmad 2011	RCT comparing intramedullary hip screw versus compression hip screw. Published only as abstracts, which contain insufficient information to justify inclusion in the review
Gupta 2012	RCT comparing cephalocondylic nail versus compression hip screw. Published only as an abstract- which contains insufficient information to justify inclusion in the review
Lee 2007	Quasi-RCT, comparing Russell-Taylor reconstruction intramedullary nail versus Dynamic condylar screw. This study was previously included in the review. Because of a change in review criteria to include only adults > 60 years of age, we excluded this study, which evaluates hip fractures in younger adults < 55 years of age.
NCT00686023	RCT, comparing inflatable PFN versus DHS. Clinical trials register states that expected study completion was in 2012. The trial register has not been updated. We excluded this study because we presume that this study has not been, or is unlikely to be, completed.
NCT00736684	RCT comparing Gamma nail versus PFNA. Clinical trials register states that study completion was in 2009. The trial register has not been updated. We excluded this study because we presume that this study has not been, or is unlikely to be, completed.
NCT01173744	RCT comparing Gamma nails with DHS. Clinical trials register states that expected study completion was in 2012. The trial register has not been updated. We excluded this study because we presume that this study has not been, or is unlikely to be, completed.
NCT01238068	RCT comparing Gamma nail with DHS. Clinical trials register states that expected study completion was in 2011. The trial register has not been updated. We excluded this study because we presume that this study has not been, or is unlikely to be, completed.
NCT03065101	RCT comparing TRIGEN INTERTAN nail with SHS. Clinical trials register states that the study was terminated because of low recruitment. We excluded this study because we did not have contact details for the principal investigator to confirm study status/recruitment, and we presume that the results of this study are unavailable.
Stern 2011	RCT comparing screws and helical blades in the treatment of trochanteric fractures. Although the study includes DHS, PFNA and Gamma nails, these implants are used in both comparison groups and the study is therefore not eligible for inclusion in the review.

DHS: dynamic hip screw; **PFN(A):** proximal femoral nail (antirotation); **RCT:** randomised controlled trial; **SHS:** sliding hip screw

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

NCT01380444

Methods	RCT, parallel design
Participants	**Estimated number of participants**: 736 participants **Inclusion criteria** • Adult men or women aged 18 years and older (with no upper age limit) • An intertrochanteric fracture (stable or unstable), AO Type 31-A1 or 31-A2, confirmed with antero-posterior and lateral hip radiographs, computed tomography, or magnetic resonance imaging • Low-energy fracture (defined as a fall from standing height) • No other major trauma. Patient was ambulatory prior to fracture, though they may have used an aid such as a cane or a walker • Anticipated medical optimisation of the patient for operative fixation of the proximal femur • Operative treatment within 7 days after the trauma. (Operative treatment should take place as soon as possible as permitted by each institution's standard of care) • Provision of informed consent by patient or proxy **Exclusion criteria** • Associated major injuries of the lower extremity (i.e. ipsilateral and/or contralateral fractures of the foot, ankle, tibia, fibula, or knee; dislocations of the ankle, knee, or hip) • Retained hardware around the affected proximal femur. Infection around the proximal femur (i.e. soft tissue or bone) • Patients with disorders of bone metabolism other than osteoporosis (i.e. Paget's disease, renal osteodystrophy, or osteomalacia) • Patients with Parkinson's disease severe enough to increase the likelihood of falling or severe enough to compromise rehabilitation • Patients with a subtrochanteric fracture • Patients with a pathologic fracture • Patients with a reverse oblique fracture pattern, fracture AO Type 31-A3 • Obesity in the judgement of the attending surgeon • Off-label use of the implant • Patients with a previous history of frank dementia that would interfere with assessment of the primary outcome (i.e. EQ-5D at 1 year) • Likely problems, in the judgement of the Site Investigators, with maintaining follow-up. We will, for example, exclude patients with no fixed address, those who report a plan to move out of town in the next year, or intellectually challenged patients without adequate family support • Patient is enrolled in another ongoing drug or surgical intervention trial • If the attending surgeon believes that there is another reason to exclude this patient from INSITE. This reason will be documented on the case report forms.
Interventions	Gamma 3 nail (Stryker) versus the Sliding Hip Screw
Outcomes	Length of follow-up: 2 years • HQRL (EQ-5D, Parker mobility score); time frame: hospital admission, post-surgery, 13 weeks, 26 weeks, 52 weeks, and 104 weeks • Fracture healing rates; time frame: up to 104 weeks • Fracture-related adverse events; time frame: up to 104 weeks • Revision surgery rates including unplanned surgery after the initial fixation to promote fracture healing (non-union), relieve pain (avascular necrosis, early or late implant failure), treat infection, or improve function will be considered a study event; time frame: up to 104 weeks

NCT01380444 *(Continued)*

Notes	Expected completion date: March 2017 Sponsor: Stryker Truama GMBH This trial is being conducted at 26 centres in 12 countries. It is likely that the REGAIN 2008 study has acted as a pilot for this trial. Study authors contacted in April 2021 and in September 2021; study authors confirmed that a publication was imminent but it was not possible to obtain preprint data. An abstract is available but it does not include sufficient outcome data.

NCT02788994

Methods	RCT, parallel design
Participants	**Expected number of participants:** 60 **Inclusion Criteria** • 55 to 95 years • Fresh unstable (AO/OTA type A2) pertrochanteric fracture • If medically fit, participant will undergo surgical fixation within 48 hours of admission. Otherwise, all participants must undergo surgery within 7 days of admission. • Informed consent/assent to participate in the study • In the opinion of investigating team, participant able to complete the study assessment and visit schedule
Interventions	Endovis BA2 nail versus DHS
Outcomes	Mobility (TUG); length of hospital stay
Notes	We contacted trialists (Peter Giannoudis) in April 2021. The trialists confirmed that publication is in process but they were unable to share data at this point.

NCT03849014

Methods	RCT
Participants	Inclusion Criteria • Trochanteric region fractures AO/OTA 31.A1 and 31.A2 • Time from fracture until surgery up to 1 week • ASA I to III • Willing to participate
Interventions	PFN versus DHS
Outcomes	Mortality and complications
Notes	

REGAIN 2008

Methods	Randomised, double blind (participant, outcomes assessor)
Participants	**Estimated number of participants**: 90 participants; 85 participants reported in a conference abstract (see Notes) **Inclusion criteria** • Adult men or women aged 50 years and older (with no upper age limit) • An intertrochanteric fracture (stable or unstable) confirmed with anterior and posterior lateral hip radiographs, computed tomography, or magnetic resonance imaging • Operative treatment within 3 days after the trauma. • Patient was ambulatory prior to fracture, though they may have used an aid such as a cane or a walker. • Anticipated medical optimalisation of the patient for operative fixation of the hip • Provision of informed consent by patient or proxy • Low-energy fracture (defined as a fall from standing height) • No other major trauma **Exclusion criteria** • Associated major injuries of the lower extremity (i.e. ipsilateral or contralateral fractures of the foot, ankle, tibia, fibula, knee, or femur; dislocations of the ankle, knee, or hip; or femoral head defects or fracture) • Retained hardware around the affected hip • Infection around the hip (i.e. soft tissue or bone) • Patients with disorders of bone metabolism other than osteoporosis (i.e. Paget's disease, renal osteodystrophy, or osteomalacia) • Moderate or severe cognitively impaired patients (i.e. 6-Item Screener with ≥ 3 errors) • Patients with Parkinson's disease (or dementia) severe enough to increase the likelihood of falling or severe enough to compromise rehabilitation • Likely problems, in the judgement of the investigators, with maintaining follow-up. The investigators will, for example, exclude patients with no fixed address, those who report a plan to move out of town in the next year, or intellectually challenged patients without adequate family support • If the attending surgeon believes that a patient should be excluded from REGAIN because the patient is enrolled in another ongoing drug or surgical intervention trial • If the attending surgeon believes that there is another reason to exclude this patient from the study. This reason will be documented on the case report forms.
Interventions	Gamma3 intramedullary nail (Stryker) versus the sliding hip screw
Outcomes	Length of follow-up: 2 years • Rates of revision surgery • HRQoL (SF-12, WOMAC, EQ-5D, Merle d'Aubigne, Parker Mobility score); time frame: hospital admission, 1 and 2 weeks and 3, 6, 9,12, 18 and 24 months • Fracture healing rates; time frame: 3, 6, 9,12, 18 and 24 months • Complications (mortality, femoral shaft fracture, avascular necrosis, non-union, malunion, implant breakage/failure, infection); time frame: hospital admission, 1 and 2 weeks and 3, 6, 9,12, 18 and 24 months
Notes	On WHO ICTR platform, the trial (NCT00555945) is documented as recruitment complete with no results posted. No response was received from Dr Sprague who was emailed on 1 August 2015 requesting a further update on the trial regarding publication. Sponsor: Stryker Truama GMBH

REGAIN 2008 *(Continued)*	This trial, which was conducted at three centres in Canada, Denmark and Sweden, was reported in a conference abstract (Bhandari 2011). It is termed a pilot study and thus it is very likely to be the pilot for NCT01380444.

ASA: American Society of Anesthesiologists; **DHS:** dynamic hip screw; **EQ-5D:** European quality of life - 5 dimensions; **HRQoL:** health-related quality of life; **PFN:** proximal femoral nail; **RCT:** randomised controlled trial; **SF-12:** short-form 12; **TUG:** Timed Up and Go test;**WOMAC:** Western Ontario and McMaster Universities Osteoarthritis Index

Characteristics of ongoing studies *[ordered by study ID]*

IRCT20141209020258N80

Study name	Comparison proximal femoral nailing (PFN) versus dynamic hip screw (DHS) in intertrochanteric fracture
Methods	RCT, parallel design
Participants	**Estimated participant enrolment:** 36 **Inclusion criteria:** intertrochantric fracture, ≥ 18 years of age, either gender, fracture < 2 weeks old, lack of multiple fractures, absence of pathologic fracture, lack of background bone disease
Interventions	PFN versus DHS
Outcomes	Wound healing; clinical improvement of fracture by radiological examination
Starting date	March 2018
Contact information	Fariba Farokhi; f.farokhi@arakmu.ac.ir; Arak University of Medical Sciences; Iran
Notes	

NCT03906032

Study name	Comparison of sliding hip screw to intramedullary nailing in the treatment of intertrochanteric hip fracture
Methods	RCT, parallel design
Participants	**Estimated participant enrolment:** 352 **Inclusion criteria** • OTA A1 and A2 fractures • ≥ 60 years of age **Exclusion criteria** • Polytrauma, high-energy hip fractures, pathological fractures • Reverse oblique and subtrochanteric femoral fractures • < 60 years of age
Interventions	TFNA IM Nail versus SHS
Outcomes	Blood loss; mortality, analgesia use; mobility (TUG), function (HHS), kinematic gait parameters at hip; length of hospital stay

NCT03906032 *(Continued)*

Starting date	April 2019
Contact information	May Cleary; may.cleary@hse.ie
Notes	Estimated completion date April 2023

DHS: dynamic hip screw; **HHS:** Harris Hip Score:**OTA:** Orthopaedic Trauma Association; **PFN:** proximal femoral nail; **RCT:** randomised controlled trial; **SHS:** sliding hip screw; **TFNA IM:** TFN-Advanced® proximal femoral nailing system - intramedullary nail; **TUG:** Timed Up and Go test

DATA AND ANALYSES

Comparison 1. Cephalomedullary nails versus extramedullary implants

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 ADL, early (≤ 4 months)	4		Std. Mean Difference (IV, Random, 95% CI)	Totals not selected
1.2 ADL (≤ 4 months; independent in performance of ADL)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.3 ADL, early (≤ 4 months; change in social dependency scale)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.4 ADL at 12 months	8	835	Std. Mean Difference (IV, Random, 95% CI)	0.01 [-0.26, 0.27]
1.5 ADL (12 months; independent in performance of ADL)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.6 ADL at 12 months (change scores in social dependency scale	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.7 Delirium	5	1310	Risk Ratio (M-H, Random, 95% CI)	1.22 [0.67, 2.22]
1.8 Functional status, early (≤ 4 months)	2	188	Std. Mean Difference (IV, Random, 95% CI)	0.02 [-0.27, 0.30]
1.9 Functional status, early (≤ 4 months; excellent or good)	2	188	Risk Ratio (M-H, Random, 95% CI)	1.04 [0.96, 1.13]
1.10 Functional status at 12 months (mean scores)	12		Std. Mean Difference (IV, Random, 95% CI)	Totals not selected
1.11 Functional status (12 months; excellent or good using HHS)	3	257	Risk Ratio (M-H, Random, 95% CI)	1.06 [0.89, 1.27]
1.12 HRQoL at 12 months	4	279	Std. Mean Difference (IV, Random, 95% CI)	0.28 [-0.15, 0.71]

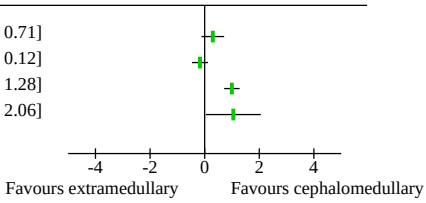
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.13 Mobility (≤ 4 months; independent mobility)	7	719	Risk Ratio (M-H, Random, 95% CI)	1.12 [1.01, 1.23]
1.14 Mobility, early (≤ 4 months; mobility scales, mean scores)	2	695	Mean Difference (IV, Random, 95% CI)	0.16 [-0.15, 0.48]
1.15 Mobility (≤ 4 months; 10 metre walking speed test)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.16 Mobility (≤ 4 months; able to complete TUG)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.17 Mobility, early (≤ 4 months; TUG, mean scores)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.18 Mobility at 12 months (mobility scales, mean scores)	14	1746	Mean Difference (IV, Random, 95% CI)	0.48 [0.10, 0.87]
1.19 Mobility (at 12 months; change from baseline)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.20 Mobility (12 months; independent mobility)	12	1524	Risk Ratio (M-H, Random, 95% CI)	1.07 [0.94, 1.22]
1.21 Mobility (12 months; able to complete TUG)	2		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.22 Mobility at 12 months (TUG, mean scores)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.23 Failure to regain pre-fracture mobility (at 12 months)	2	246	Risk Ratio (M-H, Random, 95% CI)	1.12 [0.85, 1.46]
1.24 Mobility at 12 months (remained in bed or wheelchair)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.25 Mortality, early (≤ 4 months)	30	4603	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.79, 1.18]
1.26 Mortality at 12 months	47	7618	Risk Ratio (M-H, Random, 95% CI)	0.99 [0.90, 1.08]
1.27 Unplanned return to theatre	50	8398	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.89, 1.50]
1.28 Pain, early (≤ 4 months; pain scales, mean scores)	4	832	Std. Mean Difference (IV, Random, 95% CI)	-0.13 [-0.43, 0.17]
1.29 Experiencing pain (≤ 4 months)	4	417	Risk Ratio (M-H, Random, 95% CI)	0.79 [0.42, 1.46]
1.30 Pain at 12 months (pain scales, mean scores)	6		Std. Mean Difference (IV, Random, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.31 Experiencing pain (at 12 months)	10	1552	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.75, 1.32]
1.32 Length of hospital stay (days)	26	3647	Mean Difference (IV, Random, 95% CI)	-0.52 [-1.23, 0.18]
1.33 Discharge destination (to own home/previous residence)	14	2451	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.96, 1.04]
1.34 Adverse event related to implant, fracture, or both	68		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.34.1 Intra-operative periprosthetic fracture	35		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.34.2 Postoperative periprosthetic fracture	46		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.34.3 Loosening of prosthesis	3		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.34.4 Screw cut out	49		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.34.5 Implant failure	24		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.34.6 Deep infection	35		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.34.7 Superficial infection	35		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.34.8 Non-union	40		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.35 Adverse events unrelated to implant, fracture, or both	44		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.35.1 Acute kidney injury	2		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.35.2 Blood transfusion	17		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.35.3 Cerebrovascular accident	11		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.35.4 Chest infection/pneumonia	25		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.35.5 Myocardial infarction/acute coronary syndrome	11		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.35.6 Urinary tract infection	16		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.35.7 Venous thromboembolic phenomena (DVT)	30		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.35.8 Venous thromboembolic phenomena (PE)	14		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 1.1. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 1: ADL, early (≤ 4 months)

	Cephalomedullary nail			Extramedullary implant			Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	IV, Random, 95% CI	IV, Random, 95% CI
Andalib 2020 (1)	56.07	9.7	38	53.4	8.3	55	0.30 [-0.12 , 0.71]	
Reindl 2015 (2)	99	23.79	96	103	22.64	85	-0.17 [-0.46 , 0.12]	
Sanders 2017 (2)	105.6	1.7	110	103.9	1.7	107	1.00 [0.71 , 1.28]	
Yamauchi 2014 (3)	16.3	6.85	10	9.5	5.18	8	1.05 [0.04 , 2.06]	

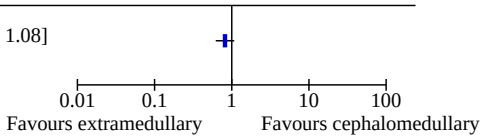


Footnotes

(1) LEM (higher scores indicate better performance in ADL)
(2) FIM (higher scores indicate better performance in ADL)
(3) Japanese Orthopaedic Association (JOA) hip functional scores (higher scores indicate better performance in ADL)

Analysis 1.2. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 2: ADL (≤ 4 months; independent in performance of ADL)

	Cephalomedullary		Extramedullary		Risk Ratio	Risk Ratio
Study or Subgroup	Events	Total	Events	Total	M-H, Fixed, 95% CI	M-H, Fixed, 95% CI
Miedel 2005 (1)	43	87	49	81	0.82 [0.62 , 1.08]	

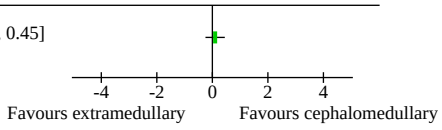


Footnotes

(1) Katz index

Analysis 1.3. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 3: ADL, early (≤ 4 months; change in social dependency scale)

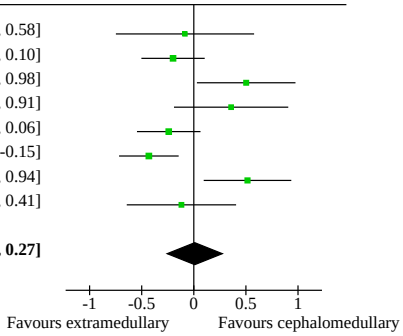
	Cephalomedullary			Extramedullary			Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	IV, Fixed, 95% CI	IV, Fixed, 95% CI
Parker 2017	1	1.6	160	0.9	1.6	165	0.10 [-0.25 , 0.45]	



Analysis 1.4. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 4: ADL at 12 months

Study or Subgroup	Cephalomedullary nail Mean	SD	Total	Extramedullary implant Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Sadowski 2002 (1)	-2.6	1	18	-2.5	1.3	17	8.6%	-0.08 [-0.75 , 0.58]
Saudan 2002 (1)	-2.88	1.16	79	-2.65	1.14	89	15.1%	-0.20 [-0.50 , 0.10]
Aktselis 2014 (2)	89.7	15.8	36	81.1	18	35	11.8%	0.50 [0.03 , 0.98]
Chechik 2014 (1)	-2.7	1.1	26	-3.1	1.1	26	10.4%	0.36 [-0.19 , 0.91]
Reindl 2015 (3)	106	23	87	111	17.83	80	15.1%	-0.24 [-0.55 , 0.06]
Sanders 2017 (3)	107.3	1.8	102	108.1	1.9	91	15.4%	-0.43 [-0.72 , -0.15]
Andalib 2020 (4)	69.34	8.9	38	64.56	9.4	55	12.8%	0.52 [0.09 , 0.94]
Eceviz 2020 (2)	92.41	6.63	29	93.15	5.57	27	10.8%	-0.12 [-0.64 , 0.41]
Total (95% CI)			**415**			**420**	**100.0%**	**0.01 [-0.26 , 0.27]**

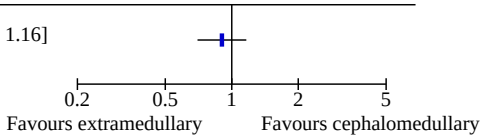
Heterogeneity: Tau² = 0.10; Chi² = 23.47, df = 7 (P = 0.001); I² = 70%
Test for overall effect: Z = 0.07 (P = 0.95)
Test for subgroup differences: Not applicable



Footnotes
(1) Jensen's score (lower scores indicate better performance in ADL; we inverted the data in analysis to be consistent with other scales)
(2) Barthel Index (higher scores indicate better performance in ADL)
(3) FIM (higher scores indicate better performance in ADL)
(4) LEM (higher scores indicate better performance in ADL)

Analysis 1.5. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 5: ADL (12 months; independent in performance of ADL)

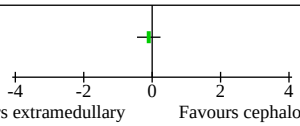
Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Risk Ratio M-H, Fixed, 95% CI
Miedel 2005 (1)	47	82	47	74	0.90 [0.70 , 1.16]



Footnotes
(1) Katz A & B

Analysis 1.6. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 6: ADL at 12 months (change scores in social dependency scale

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
Parker 2017 (1)	0.4	1.5	138	0.5	1.4	137	-0.10 [-0.44 , 0.24]

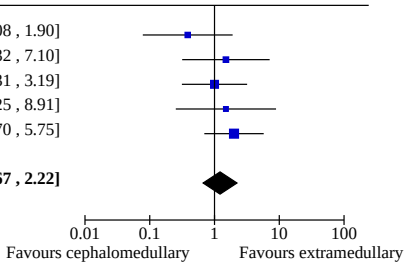


Footnotes
(1) Change from baseline scores, social dependency scale (higher scores indicate better performance in ADL)

Analysis 1.7. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 7: Delirium

Study or Subgroup	Cephalomedullary nail Events	Total	Extramedullary implant Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Hoffmann 1999	2	56	5	54	14.2%	0.39 [0.08 , 1.90]
Papasimos 2005	6	80	2	40	15.0%	1.50 [0.32 , 7.10]
Varela-Egocheaga 2009	5	40	5	40	26.9%	1.00 [0.31 , 3.19]
Parker 2012	3	300	2	300	11.4%	1.50 [0.25 , 8.91]
Parker 2017	10	200	5	200	32.5%	2.00 [0.70 , 5.75]
Total (95% CI)		**676**		**634**	**100.0%**	**1.22 [0.67 , 2.22]**
Total events:	26		19			

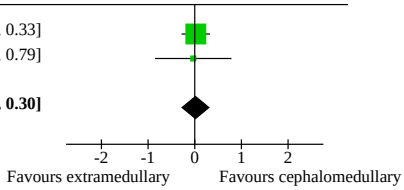
Heterogeneity: Tau² = 0.00; Chi² = 3.07, df = 4 (P = 0.55); I² = 0%
Test for overall effect: Z = 0.64 (P = 0.52)
Test for subgroup differences: Not applicable



Analysis 1.8. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 8: Functional status, early (≤ 4 months)

Study or Subgroup	Cephalomedullary nail Mean	SD	Total	Extramedullary implant Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Kouvidis 2012 (1)	64.19	25.94	86	63.65	20.94	79	87.8%	0.02 [-0.28 , 0.33]
Guerra 2014 (2)	28.45	10.84	11	28.83	12.09	12	12.2%	-0.03 [-0.85 , 0.79]
Total (95% CI)			**97**			**91**	**100.0%**	**0.02 [-0.27 , 0.30]**

Heterogeneity: Tau² = 0.00; Chi² = 0.01, df = 1 (P = 0.90); I² = 0%
Test for overall effect: Z = 0.11 (P = 0.91)
Test for subgroup differences: Not applicable

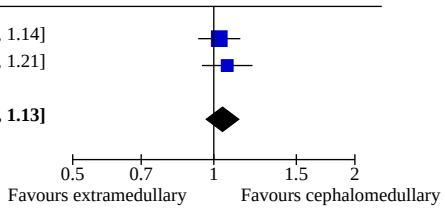


Footnotes
(1) Functional recovery score (0 to 100; higher scores indicate better function)
(2) Zűckerman functional recovery scores (0 to 44; higher scores indicate better function)

Analysis 1.9. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 9: Functional status, early (≤ 4 months; excellent or good)

Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Hoffmann 1999 (1)	43	45	40	43	59.0%	1.03 [0.93 , 1.14]
Xu 2018 (2)	47	50	44	50	41.0%	1.07 [0.94 , 1.21]
Total (95% CI)		**95**		**93**	**100.0%**	**1.04 [0.96 , 1.13]**
Total events:	90		84			

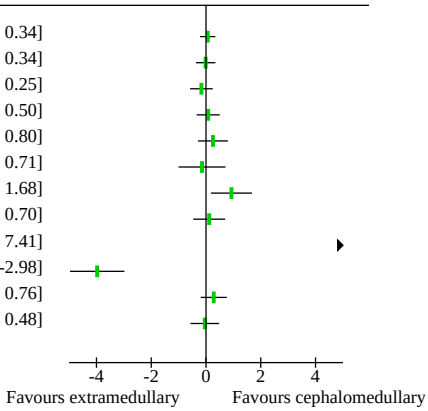
Heterogeneity: Tau² = 0.00; Chi² = 0.24, df = 1 (P = 0.63); I² = 0%
Test for overall effect: Z = 1.06 (P = 0.29)
Test for subgroup differences: Not applicable



Footnotes
(1) Merle d'Aubigne (Excellent or good)
(2) HHS (Excellent or good)

Analysis 1.10. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 10: Functional status at 12 months (mean scores)

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Std. Mean Difference IV, Random, 95% CI
Cai 2016 (1)	36.1	2.38	106	35.96	1.99	92	0.06 [-0.22 , 0.34]
Kouvidis 2012 (2)	74.33	25.19	62	74.66	21.21	60	-0.01 [-0.37 , 0.34]
Gou 2013 (3)	22.8	7	45	24	7.2	45	-0.17 [-0.58 , 0.25]
Tao 2013 (4)	82.8	9.5	45	82	10.4	42	0.08 [-0.34 , 0.50]
Chechik 2014 (5)	67	15	26	63	16	26	0.25 [-0.29 , 0.80]
Guerra 2014 (6)	33.8	7.11	10	35.09	9.61	11	-0.15 [-1.00 , 0.71]
Haq 2014 (5)	81.53	13.21	17	68.43	14.36	14	0.93 [0.18 , 1.68]
Singh 2017 (5)	82.8	10.5	23	81	18.8	22	0.12 [-0.47 , 0.70]
Li 2018 (5)	85.3	2.4	40	72.3	1.6	40	6.31 [5.22 , 7.41]
Singh 2019 (4)	79.73	1.2	24	85.46	1.6	25	-3.97 [-4.97 , -2.98]
Adeel 2020 (5)	87.62	17.28	34	81.83	23.01	34	0.28 [-0.20 , 0.76]
Eceviz 2020 (5)	70.38	10.1	29	70.81	8.99	27	-0.04 [-0.57 , 0.48]



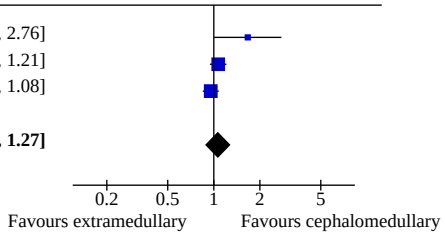
Footnotes

(1) Zűckerman (0 to 44; higher scores indicate better function)
(2) Functional recovery score (0 to 100; higher scores indicate better function)
(3) OHS (range 0 to 48, higher scores indicate better function)
(4) Modified HHS (higher scores indicate better function)
(5) HHS (higher scores indicate better function)
(6) Zűckerman (0 to 44; higher scores indicate better function)

Analysis 1.11. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 11: Functional status (12 months; excellent or good using HHS)

Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Chen 2018 (1)	15	18	9	18	10.1%	1.67 [1.00 , 2.76]
Xu 2018 (2)	47	50	44	50	44.6%	1.07 [0.94 , 1.21]
Zou 2009 (3)	51	58	58	63	45.3%	0.96 [0.85 , 1.08]
Total (95% CI)		**126**		**131**	**100.0%**	**1.06 [0.89 , 1.27]**
Total events:	113		111			

Heterogeneity: $Tau^2 = 0.01$; $Chi^2 = 5.99$, df = 2 (P = 0.05); $I^2 = 67\%$
Test for overall effect: Z = 0.67 (P = 0.51)
Test for subgroup differences: Not applicable



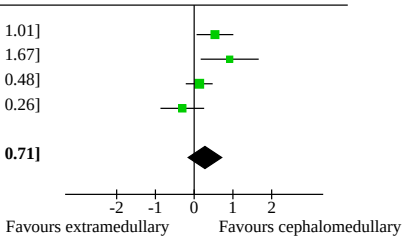
Footnotes

(1) Sanders (higher scores indicate better function)
(2) Modified HHS (higher scores indicate better function)
(3) Salvati and Wilson (higher scores indicate better function)

Analysis 1.12. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 12: HRQoL at 12 months

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Aktselis 2014 (1)	0.9	0.16	36	0.78	0.27	35	26.8%	0.54 [0.06 , 1.01]
Haq 2014 (2)	41.83	12.28	17	31.18	9.99	14	18.1%	0.92 [0.17 , 1.67]
Carulli 2017 (3)	59.7	10.04	66	58.4	9.78	62	31.5%	0.13 [-0.22 , 0.48]
Singh 2019 (3)	43.56	11.25	24	47	10.89	25	23.6%	-0.31 [-0.87 , 0.26]
Total (95% CI)			**143**			**136**	**100.0%**	**0.28 [-0.15 , 0.71]**

Heterogeneity: Tau² = 0.12; Chi² = 8.63, df = 3 (P = 0.03); I² = 65%
Test for overall effect: Z = 1.26 (P = 0.21)
Test for subgroup differences: Not applicable

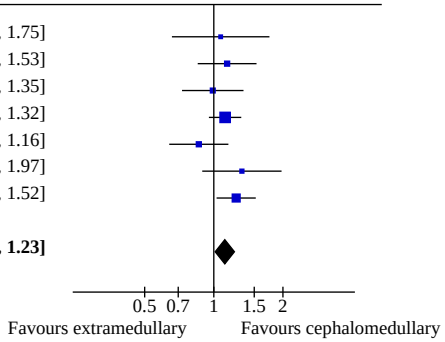


Footnotes
(1) EQ-5D
(2) SF-12, PCS
(3) SF-12 (PCS)

Analysis 1.13. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 13: Mobility (≤ 4 months; independent mobility)

Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Guyer 1991 (1)	15	28	16	32	3.9%	1.07 [0.66 , 1.75]
Park 1998 (2)	24	30	21	30	10.7%	1.14 [0.85 , 1.53]
Hoffmann 1999 (1)	29	45	28	43	9.8%	0.99 [0.73 , 1.35]
Pajarinen 2005 (3)	39	42	34	41	35.2%	1.12 [0.95 , 1.32]
Ovesen 2006 (4)	37	73	43	73	10.5%	0.86 [0.64 , 1.16]
Ekstrom 2007	35	75	25	71	5.9%	1.33 [0.89 , 1.97]
Carulli 2017	58	69	45	67	24.0%	1.25 [1.03 , 1.52]
Total (95% CI)		**362**		**357**	**100.0%**	**1.12 [1.01 , 1.23]**
Total events:	237		212			

Heterogeneity: Tau² = 0.00; Chi² = 5.69, df = 6 (P = 0.46); I² = 0%
Test for overall effect: Z = 2.25 (P = 0.02)
Test for subgroup differences: Not applicable

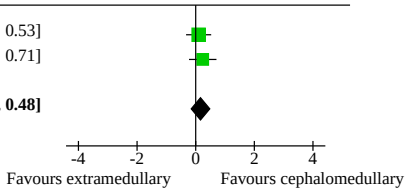


Footnotes
(1) Walking without aid or with one aid
(2) Mobile with stick or no aid
(3) Independent with aid or no aids
(4) Mobile with sticks, crutches or no aid

Analysis 1.14. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 14: Mobility, early (≤ 4 months; mobility scales, mean scores)

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Parker 2012 (1)	3.8	2.1	181	3.7	2.1	189	54.4%	0.10 [-0.33 , 0.53]
Parker 2017 (1)	4.81	2.2	161	4.57	2.1	164	45.6%	0.24 [-0.23 , 0.71]
Total (95% CI)			**342**			**353**	**100.0%**	**0.16 [-0.15 , 0.48]**

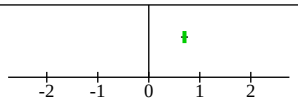
Heterogeneity: Tau² = 0.00; Chi² = 0.19, df = 1 (P = 0.67); I² = 0%
Test for overall effect: Z = 1.02 (P = 0.31)
Test for subgroup differences: Not applicable



Footnotes
(1) Higher scores indicate better mobility

Analysis 1.15. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 15: Mobility (≤ 4 months; 10 metre walking speed test)

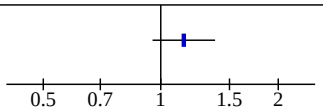
Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Li 2018 (1)	1.6	0.2	40	0.9	0.1	40	0.70 [0.63 , 0.77]	



Footnotes
(1) 10 metre walking speed test (m/s)

Analysis 1.16. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 16: Mobility (≤ 4 months; able to complete TUG)

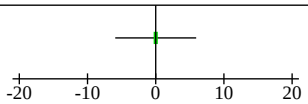
Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
Sanders 2017 (1)	85	123	76	126	1.15 [0.95 , 1.38]	



Footnotes
(1) Able to complete TUG test

Analysis 1.17. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 17: Mobility, early (≤ 4 months; TUG, mean scores)

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Reindl 2015 (1)	26	18.95	87	26	20.07	80	0.00 [-5.93 , 5.93]	

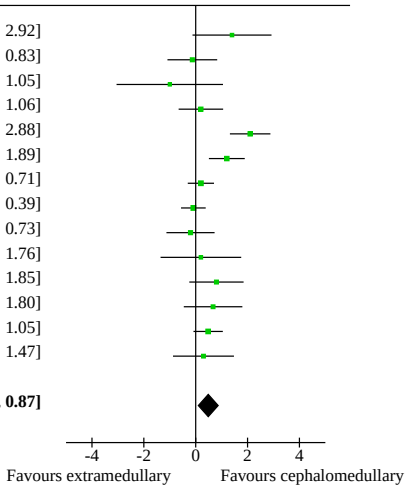


Footnotes
(1) TUG (seconds)

Analysis 1.18. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 18: Mobility at 12 months (mobility scales, mean scores)

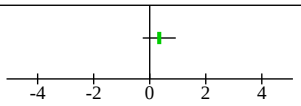
Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Hardy 1998	4.8	3.2	35	3.4	3.3	35	4.2%	1.40 [-0.12 , 2.92]
Saudan 2002	4.94	3.33	79	5.07	2.97	89	7.1%	-0.13 [-1.09 , 0.83]
Sadowski 2002	5	2.6	18	6	3.5	17	2.7%	-1.00 [-3.05 , 1.05]
Utrilla 2005	6.4	2.8	82	6.2	2.79	81	7.8%	0.20 [-0.66 , 1.06]
Little 2008	5.9	2.67	76	3.8	2.28	80	8.3%	2.10 [1.32 , 2.88]
Xu 2010	5.6	1.4	40	4.4	1.8	43	9.0%	1.20 [0.51 , 1.89]
Parker 2012	4.84	2.7	209	4.64	2.6	213	10.5%	0.20 [-0.31 , 0.71]
Han 2012	7.59	1.12	41	7.68	1.09	42	10.7%	-0.09 [-0.57 , 0.39]
Gou 2013	6.7	2.8	45	6.9	1.5	45	7.3%	-0.20 [-1.13 , 0.73]
Chechik 2014	4.3	3.1	26	4.1	2.6	26	4.1%	0.20 [-1.36 , 1.76]
Aktselis 2014	6.5	2.3	36	5.7	2.2	35	6.5%	0.80 [-0.25 , 1.85]
Haq 2014	7.53	1.807	17	6.86	1.4	14	6.0%	0.67 [-0.46 , 1.80]
Parker 2017	5.95	2.5	139	5.47	2.3	138	10.0%	0.48 [-0.09 , 1.05]
Singh 2017	6.3	2.1	23	6	1.92	22	5.8%	0.30 [-0.87 , 1.47]
Total (95% CI)			**866**			**880**	**100.0%**	**0.48 [0.10 , 0.87]**

Heterogeneity: Tau² = 0.30; Chi² = 35.31, df = 13 (P = 0.0008); I² = 63%
Test for overall effect: Z = 2.49 (P = 0.01)
Test for subgroup differences: Not applicable



Analysis 1.19. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 19: Mobility (at 12 months; change from baseline)

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
Barton 2010 (1)	1.83	1.83	65	1.49	1.83	86	0.34 [-0.25 , 0.93]

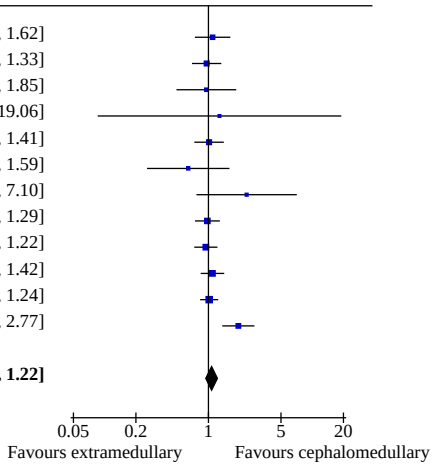


Footnotes
(1) Mobility scale (5-point scale; lower scores indicate better mobility)

Analysis 1.20. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 20: Mobility (12 months; independent mobility)

Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Leung 1992	34	93	31	93	7.9%	1.10 [0.74 , 1.62]
Ahrengart 1994 (1)	49	169	54	179	10.2%	0.96 [0.69 , 1.33]
Goldhagen 1994	10	29	13	36	3.4%	0.95 [0.49 , 1.85]
Haynes 1996	1	18	1	23	0.2%	1.28 [0.09 , 19.06]
Kukla 1997 (2)	28	45	27	44	10.1%	1.01 [0.73 , 1.41]
Kuwabara 1998 (3)	5	20	9	23	1.9%	0.64 [0.26 , 1.59]
Pelet 2001 (4)	7	13	3	13	1.3%	2.33 [0.77 , 7.10]
Adams 2001	56	126	55	121	12.4%	0.98 [0.74 , 1.29]
Ekstrom 2007	41	64	38	56	13.4%	0.94 [0.73 , 1.22]
Varela-Egocheaga 2009 (5)	30	38	26	36	13.2%	1.09 [0.84 , 1.42]
Tao 2013	37	45	34	42	17.0%	1.02 [0.83 , 1.24]
Zehir 2015	53	96	29	102	9.0%	1.94 [1.36 , 2.77]
Total (95% CI)		**756**		**768**	**100.0%**	**1.07 [0.94 , 1.22]**
Total events:	351		320			

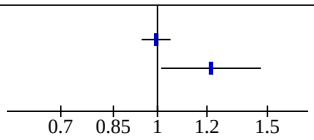
Heterogeneity: Tau² = 0.02; Chi² = 16.33, df = 11 (P = 0.13); I² = 33%
Test for overall effect: Z = 1.06 (P = 0.29)
Test for subgroup differences: Not applicable



Footnotes
(1) We reversed data described as needing a walking aid in publication by Ahrengart 1994
(2) We reversed data reported as impaired walking
(3) Walking independently or with stick
(4) We reversed data reported as needing walking aids
(5) Active with cane or no assistance

Analysis 1.21. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 21: Mobility (12 months; able to complete TUG)

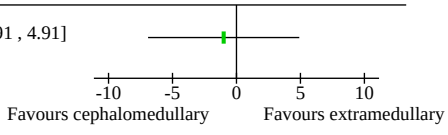
Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Risk Ratio M-H, Random, 95% CI
Matre 2013 (1)	132	139	126	132	0.99 [0.94 , 1.05]
Sanders 2017 (2)	88	123	74	126	1.22 [1.01 , 1.46]



Footnotes
(1) Passed TUG
(2) Able to complete TUG test

Analysis 1.22. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 22: Mobility at 12 months (TUG, mean scores)

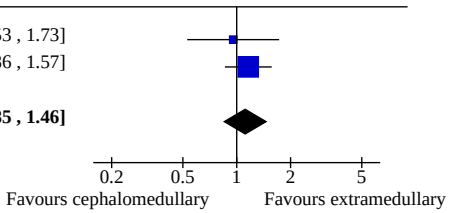
Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
Reindl 2015	19	22.74	87	20	15.87	80	-1.00 [-6.91 , 4.91]



Analysis 1.23. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 23: Failure to regain pre-fracture mobility (at 12 months)

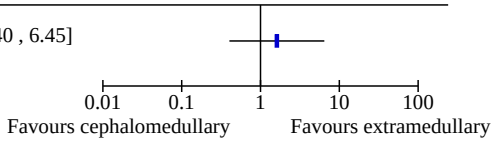
Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
Baumgaertner 1998	15	52	16	53	20.6%	0.96 [0.53 , 1.73]
Davis 1988	40	68	37	73	79.4%	1.16 [0.86 , 1.57]
Total (95% CI)		**120**		**126**	**100.0%**	**1.12 [0.85 , 1.46]**
Total events:	55		53			

Heterogeneity: Tau² = 0.00; Chi² = 0.34, df = 1 (P = 0.56); I² = 0%
Test for overall effect: Z = 0.79 (P = 0.43)
Test for subgroup differences: Not applicable



Analysis 1.24. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 24: Mobility at 12 months (remained in bed or wheelchair)

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Risk Ratio M-H, Fixed, 95% CI
Kouvidis 2012	5	62	3	60	1.61 [0.40 , 6.45]



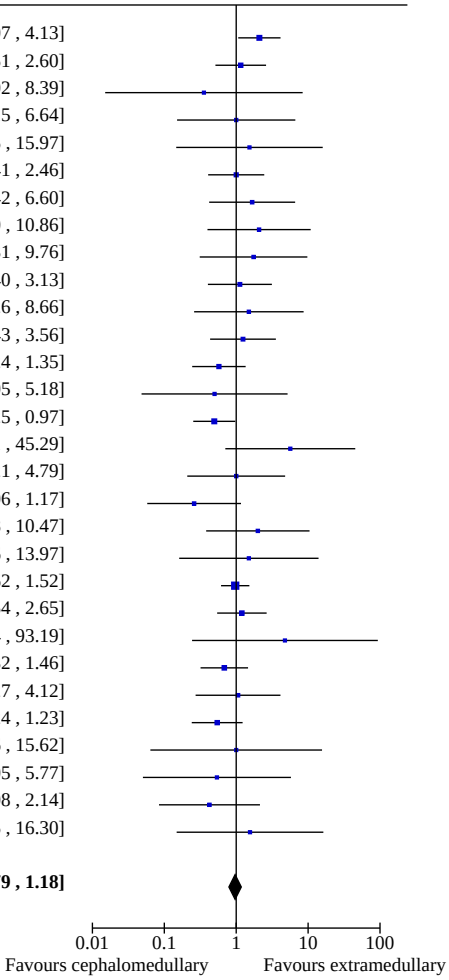
Analysis 1.25. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 25: Mortality, early (≤ 4 months)

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
Barton 2010	21	100	11	110	8.5%	2.10 [1.07 , 4.13]
Bridle 1991	10	49	9	51	6.0%	1.16 [0.51 , 2.60]
Chechik 2014	0	29	1	31	0.4%	0.36 [0.02 , 8.39]
Dujardin 2001	2	30	2	30	1.1%	1.00 [0.15 , 6.64]
Giraud 2005	2	34	1	26	0.7%	1.53 [0.15 , 15.97]
Guyer 1991	8	50	8	50	4.9%	1.00 [0.41 , 2.46]
Hardy 1998	5	50	3	50	2.1%	1.67 [0.42 , 6.60]
Harrington 2002	4	50	2	52	1.4%	2.08 [0.40 , 10.86]
Hoffman 1996	3	31	2	36	1.3%	1.74 [0.31 , 9.76]
Hoffmann 1999	7	56	6	54	3.7%	1.13 [0.40 , 3.13]
Kukla 1997	3	60	2	60	1.3%	1.50 [0.26 , 8.66]
Little 2008	7	92	6	98	3.5%	1.24 [0.43 , 3.56]
Matre 2013	8	341	14	343	5.3%	0.57 [0.24 , 1.35]
Michos 2001	1	26	2	26	0.7%	0.50 [0.05 , 5.18]
Miedel 2005	11	109	22	108	8.6%	0.50 [0.25 , 0.97]
O'Brien 1995	6	52	1	49	0.9%	5.65 [0.71 , 45.29]
Ovesen 2006	3	73	3	73	1.6%	1.00 [0.21 , 4.79]
Pahlpatz 1993	2	51	8	53	1.7%	0.26 [0.06 , 1.17]
Pajarinen 2005	4	54	2	54	1.4%	2.00 [0.38 , 10.47]
Papasimos 2005	3	80	1	40	0.8%	1.50 [0.16 , 13.97]
Parker 2017	31	200	32	200	19.0%	0.97 [0.62 , 1.52]
Radford 1993	12	100	10	100	6.2%	1.20 [0.54 , 2.65]
Sadowski 2002	2	20	0	19	0.4%	4.76 [0.24 , 93.19]
Sanders 2017	10	123	15	126	6.8%	0.68 [0.32 , 1.46]
Saudan 2002	4	100	4	106	2.1%	1.06 [0.27 , 4.12]
Utrilla 2005	8	104	15	106	5.9%	0.54 [0.24 , 1.23]
Verettas 2010	1	60	1	60	0.5%	1.00 [0.06 , 15.62]
Xu 2010	1	51	2	55	0.7%	0.54 [0.05 , 5.77]
Zehir 2015	2	96	5	102	1.5%	0.42 [0.08 , 2.14]
Zhou 2012	2	36	1	28	0.7%	1.56 [0.15 , 16.30]
Total (95% CI)		**2307**		**2296**	**100.0%**	**0.96 [0.79 , 1.18]**
Total events:	183		191			

Heterogeneity: Tau² = 0.00; Chi² = 25.82, df = 29 (P = 0.64); I² = 0%

Test for overall effect: Z = 0.35 (P = 0.72)

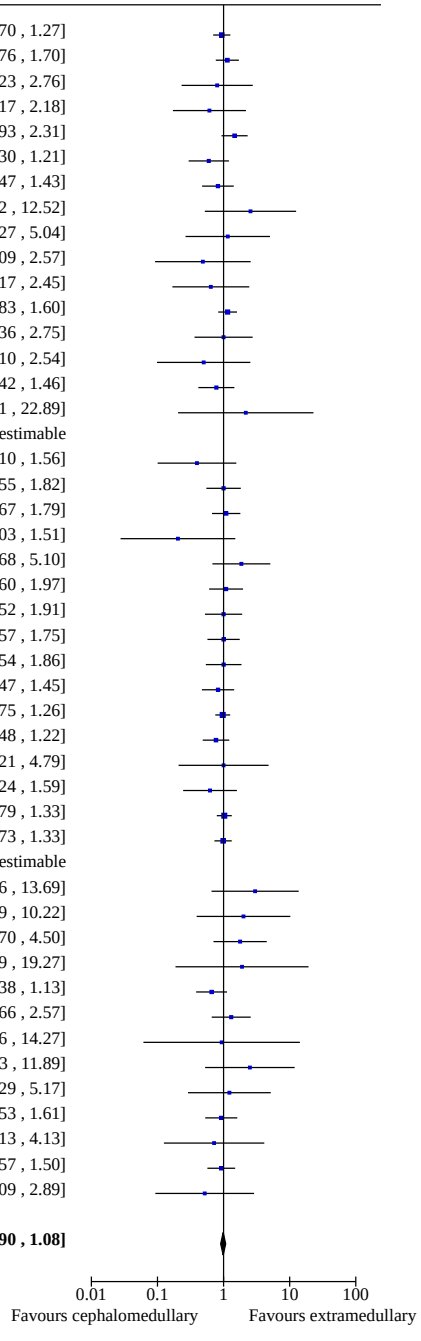
Test for subgroup differences: Not applicable



Analysis 1.26. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 26: Mortality at 12 months

Study or Subgroup	Cephalomedullary nail Events	Total	Extramedullary implant Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Adams 2001	59	203	61	197	8.5%	0.94 [0.70 , 1.27]
Ahrengart 1994	41	210	37	216	4.7%	1.14 [0.76 , 1.70]
Aktselis 2014	4	40	5	40	0.5%	0.80 [0.23 , 2.76]
Andalib 2020	3	43	8	70	0.5%	0.61 [0.17 , 2.18]
Barton 2010	32	100	24	110	3.7%	1.47 [0.93 , 2.31]
Baumgaertner 1998	10	65	17	66	1.6%	0.60 [0.30 , 1.21]
Bridle 1991	15	49	19	51	2.5%	0.82 [0.47 , 1.43]
Butt 1995	5	47	2	48	0.3%	2.55 [0.52 , 12.52]
Cai 2016	4	106	3	92	0.4%	1.16 [0.27 , 5.04]
Carulli 2017	2	71	4	69	0.3%	0.49 [0.09 , 2.57]
Chechik 2014	3	29	5	31	0.4%	0.64 [0.17 , 2.45]
Davis 1988	48	116	41	114	7.2%	1.15 [0.83 , 1.60]
Dujardin 2001	6	30	6	30	0.7%	1.00 [0.36 , 2.75]
Eceviz 2020	2	32	4	32	0.3%	0.50 [0.10 , 2.54]
Ekstrom 2007	15	105	18	98	1.9%	0.78 [0.42 , 1.46]
Goldhagen 1994	2	36	1	39	0.1%	2.17 [0.21 , 22.89]
Gou 2013	0	45	0	45		Not estimable
Guerra 2014	2	12	8	19	0.4%	0.40 [0.10 , 1.56]
Hardy 1998	15	50	15	50	2.1%	1.00 [0.55 , 1.82]
Harrington 2002	20	50	19	52	3.1%	1.09 [0.67 , 1.79]
Haynes 1996	1	19	8	31	0.2%	0.20 [0.03 , 1.51]
Hoffman 1996	8	31	5	36	0.8%	1.86 [0.68 , 5.10]
Kouvidis 2012	19	86	16	79	2.2%	1.09 [0.60 , 1.97]
Kukla 1997	14	60	14	60	1.8%	1.00 [0.52 , 1.91]
Leung 1992	20	113	20	113	2.4%	1.00 [0.57 , 1.75]
Little 2008	16	92	17	98	2.0%	1.00 [0.54 , 1.86]
Lopez 2002	13	43	22	60	2.4%	0.82 [0.47 , 1.45]
Matre 2013	84	341	87	343	11.4%	0.97 [0.75 , 1.26]
Miedel 2005	24	109	31	108	3.6%	0.77 [0.48 , 1.22]
Ovesen 2006	3	73	3	73	0.3%	1.00 [0.21 , 4.79]
Pahlpatz 1993	6	51	10	53	0.9%	0.62 [0.24 , 1.59]
Parker 2012	83	300	81	300	11.2%	1.02 [0.79 , 1.33]
Parker 2017	59	200	60	200	8.4%	0.98 [0.73 , 1.33]
Pelet 2001	0	13	0	13		Not estimable
Rahme 2007	6	30	2	30	0.3%	3.00 [0.66 , 13.69]
Raimondo 2012	4	35	2	35	0.3%	2.00 [0.39 , 10.22]
Reindl 2015	13	112	6	92	0.9%	1.78 [0.70 , 4.50]
Sadowski 2002	2	20	1	19	0.1%	1.90 [0.19 , 19.27]
Sanders 2017	18	123	28	126	2.7%	0.66 [0.38 , 1.13]
Saudan 2002	16	100	13	106	1.7%	1.30 [0.66 , 2.57]
Sharma 2018	1	31	1	29	0.1%	0.94 [0.06 , 14.27]
Singh 2019	5	30	2	30	0.3%	2.50 [0.53 , 11.89]
Tao 2013	4	49	3	45	0.4%	1.22 [0.29 , 5.17]
Utrilla 2005	19	104	21	106	2.5%	0.92 [0.53 , 1.61]
Xu 2010	2	51	3	55	0.3%	0.72 [0.13 , 4.13]
Zehir 2015	23	93	26	97	3.3%	0.92 [0.57 , 1.50]
Zhou 2012	2	36	3	28	0.3%	0.52 [0.09 , 2.89]
Total (95% CI)		**3784**		**3834**	**100.0%**	**0.99 [0.90 , 1.08]**
Total events:	753		782			

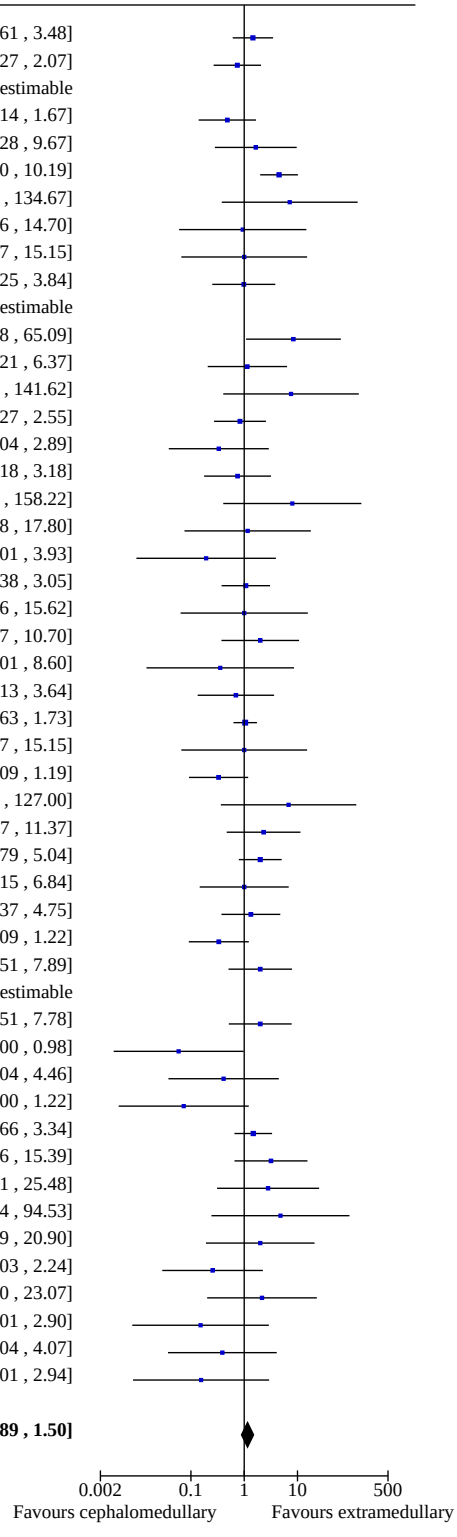
Heterogeneity: Tau² = 0.00; Chi² = 29.75, df = 44 (P = 0.95); I² = 0%
Test for overall effect: Z = 0.31 (P = 0.75)
Test for subgroup differences: Not applicable



Analysis 1.27. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 27: Unplanned return to theatre

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
Adams 2001	12	203	8	197	5.1%	1.46 [0.61 , 3.48]
Ahrengart 1994	6	105	8	104	4.2%	0.74 [0.27 , 2.07]
Aktselis 2014	0	40	0	40		Not estimable
Andalib 2020	3	38	9	55	3.2%	0.48 [0.14 , 1.67]
Barton 2010	3	100	2	110	1.8%	1.65 [0.28 , 9.67]
Benum 1994	29	429	7	467	5.5%	4.51 [2.00 , 10.19]
Butt 1995	3	47	0	48	0.7%	7.15 [0.38 , 134.67]
Carulli 2017	1	66	1	62	0.8%	0.94 [0.06 , 14.70]
Chechik 2014	1	26	1	26	0.8%	1.00 [0.07 , 15.15]
Davis 1988	4	116	4	114	2.8%	0.98 [0.25 , 3.84]
Eceviz 2020	0	29	0	27		Not estimable
Ekstrom 2007	9	105	1	98	1.4%	8.40 [1.08 , 65.09]
Giraud 2005	3	34	2	26	1.9%	1.15 [0.21 , 6.37]
Goldhagen 1994	3	36	0	39	0.7%	7.57 [0.40 , 141.62]
Guyer 1991	5	50	6	50	3.7%	0.83 [0.27 , 2.55]
Haq 2014	1	17	3	17	1.3%	0.33 [0.04 , 2.89]
Hardy 1998	3	50	4	50	2.5%	0.75 [0.18 , 3.18]
Haynes 1996	2	19	0	31	0.7%	8.00 [0.40 , 158.22]
Hoffman 1996	1	31	1	36	0.8%	1.16 [0.08 , 17.80]
Hoffmann 1999	0	56	2	54	0.7%	0.19 [0.01 , 3.93]
Kouvidis 2012	7	86	6	79	4.1%	1.07 [0.38 , 3.05]
Kukla 1997	1	60	1	60	0.8%	1.00 [0.06 , 15.62]
Leung 1992	4	113	2	113	2.0%	2.00 [0.37 , 10.70]
Little 2008	0	92	1	98	0.6%	0.35 [0.01 , 8.60]
Lopez 2002	2	43	4	60	2.0%	0.70 [0.13 , 3.64]
Matre 2013	28	341	27	343	8.3%	1.04 [0.63 , 1.73]
Michos 2001	1	26	1	26	0.8%	1.00 [0.07 , 15.15]
Miedel 2005	3	109	9	108	3.1%	0.33 [0.09 , 1.19]
Mott 1993	3	35	0	34	0.7%	6.81 [0.36 , 127.00]
O'Brien 1995	5	53	2	49	2.2%	2.31 [0.47 , 11.37]
Ovesen 2006	12	73	6	73	4.8%	2.00 [0.79 , 5.04]
Pajarinen 2005	2	54	2	54	1.6%	1.00 [0.15 , 6.84]
Papasimos 2005	8	80	3	40	3.1%	1.33 [0.37 , 4.75]
Parker 2012	3	300	9	300	3.0%	0.33 [0.09 , 1.22]
Parker 2017	6	200	3	200	2.8%	2.00 [0.51 , 7.89]
Pelet 2001	0	13	0	13		Not estimable
Radford 1993	6	100	3	100	2.8%	2.00 [0.51 , 7.78]
Rahme 2007	0	30	8	30	0.8%	0.06 [0.00 , 0.98]
Reindl 2015	1	112	2	92	1.1%	0.41 [0.04 , 4.46]
Sadowski 2002	0	20	6	19	0.8%	0.07 [0.00 , 1.22]
Sanders 2017	13	123	9	126	5.5%	1.48 [0.66 , 3.34]
Saudan 2002	6	100	2	106	2.2%	3.18 [0.66 , 15.39]
Sharma 2018	3	31	1	29	1.2%	2.81 [0.31 , 25.48]
Singh 2017	2	23	0	22	0.7%	4.79 [0.24 , 94.53]
Singh 2019	2	30	1	30	1.1%	2.00 [0.19 , 20.90]
Utrilla 2005	1	104	4	106	1.3%	0.25 [0.03 , 2.24]
Xu 2010	2	51	1	55	1.1%	2.16 [0.20 , 23.07]
Zehir 2015	0	96	3	102	0.7%	0.15 [0.01 , 2.90]
Zhou 2012	1	36	2	28	1.1%	0.39 [0.04 , 4.07]
Zou 2009	0	58	3	63	0.7%	0.15 [0.01 , 2.94]
Total (95% CI)		**4189**		**4209**	**100.0%**	**1.15 [0.89 , 1.50]**
Total events:	211		180			

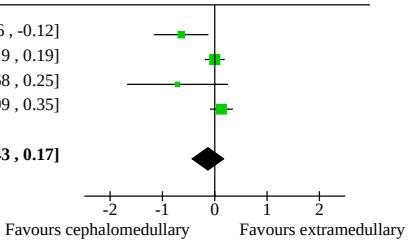
Heterogeneity: Tau² = 0.14; Chi² = 57.85, df = 46 (P = 0.11); I² = 20%
Test for overall effect: Z = 1.09 (P = 0.28)
Test for subgroup differences: Not applicable



Analysis 1.28. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 28: Pain, early (≤ 4 months; pain scales, mean scores)

Study or Subgroup	Cephalomedullary nail Mean	SD	Total	Extramedullary implant Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Dujardin 2001 (1)	-9.5	2.1	30	-8	2.5	30	18.9%	-0.64 [-1.16 , -0.12]
Matre 2013 (2)	25	21.7	226	25	21.7	206	37.5%	0.00 [-0.19 , 0.19]
Yamauchi 2014 (3)	-26.5	5.8	10	-21.25	8.35	8	7.9%	-0.71 [-1.68 , 0.25]
Parker 2017 (4)	1.5	0.83	159	1.4	0.73	163	35.7%	0.13 [-0.09 , 0.35]
Total (95% CI)			**425**			**407**	**100.0%**	**-0.13 [-0.43 , 0.17]**

Heterogeneity: Tau² = 0.05; Chi² = 9.22, df = 3 (P = 0.03); I² = 67%
Test for overall effect: Z = 0.86 (P = 0.39)
Test for subgroup differences: Not applicable

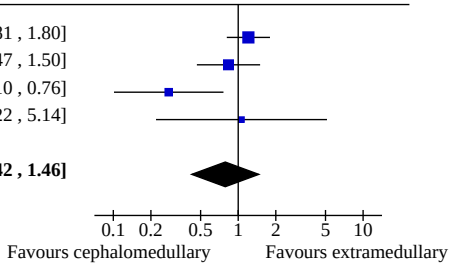


Footnotes
(1) Using Salvati and Wilson (higher scores indicate less pain, scale inverted in analysis)
(2) VAS score (lower scores indicate less pain)
(3) Japanese Orthopaedic Association (JOA) hip functional scores (higher scores indicate less pain, scale inverted in analysis)
(4) Lower scores indicate less pain

Analysis 1.29. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 29: Experiencing pain (≤ 4 months)

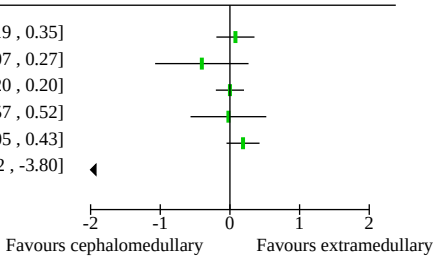
Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Guyer 1991	19	28	18	32	37.0%	1.21 [0.81 , 1.80]
Hoffmann 1999	14	45	16	43	31.5%	0.84 [0.47 , 1.50]
Aktselis 2014	4	36	14	35	20.2%	0.28 [0.10 , 0.76]
Zehir 2015	3	96	3	102	11.4%	1.06 [0.22 , 5.14]
Total (95% CI)		**205**		**212**	**100.0%**	**0.79 [0.42 , 1.46]**
Total events:	40		51			

Heterogeneity: Tau² = 0.23; Chi² = 8.21, df = 3 (P = 0.04); I² = 63%
Test for overall effect: Z = 0.76 (P = 0.45)
Test for subgroup differences: Not applicable



Analysis 1.30. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 30: Pain at 12 months (pain scales, mean scores)

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Std. Mean Difference IV, Random, 95% CI
Saudan 2002 (1)	1.36	0.63	100	1.31	0.63	106	0.08 [-0.19 , 0.35]
Sadowski 2002 (1)	1.44	0.86	18	1.77	0.73	17	-0.40 [-1.07 , 0.27]
Matre 2013 (2)	17	19.87	185	17	19.87	192	0.00 [-0.20 , 0.20]
Chechik 2014 (3)	-36.1	10.1	26	-35.9	7.9	26	-0.02 [-0.57 , 0.52]
Parker 2017 (4)	1.2	0.62	138	1.1	0.42	137	0.19 [-0.05 , 0.43]
Li 2018 (5)	4.2	0.2	40	5.4	0.3	40	-4.66 [-5.52 , -3.80]

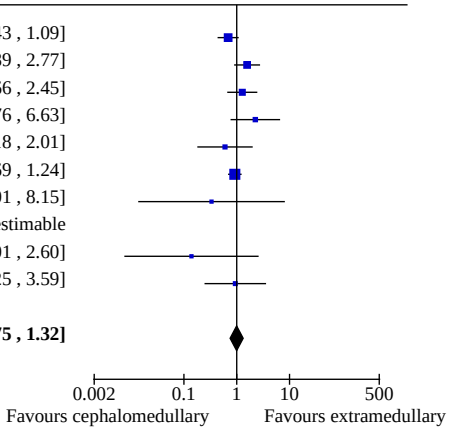


Footnotes
(1) Pain scale (1 no pain, 4 severe pain)
(2) VAS score (lower scores indicate less pain)
(3) HHS sub-score (higher scores indicate less pain, we inverted data in this analysis)
(4) Lower scores indicate less pain
(5) VAS (10 point scale; lower scores indicate less pain)

Analysis 1.31. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 31: Experiencing pain (at 12 months)

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
Leung 1992	22	93	32	93	21.3%	0.69 [0.43 , 1.09]
Ahrengart 1994	25	88	15	83	16.6%	1.57 [0.89 , 2.77]
Baumgaertner 1998	15	52	12	53	13.5%	1.27 [0.66 , 2.45]
Hardy 1998	9	35	4	35	6.0%	2.25 [0.76 , 6.63]
Pelet 2001	3	13	5	13	5.0%	0.60 [0.18 , 2.01]
Utrilla 2005	41	82	44	81	31.8%	0.92 [0.69 , 1.24]
Parker 2012	0	300	1	300	0.8%	0.33 [0.01 , 8.15]
Calderon 2013	0	16	0	16		Not estimable
Aktselis 2014	0	36	3	35	0.9%	0.14 [0.01 , 2.60]
Carulli 2017	4	66	4	62	4.1%	0.94 [0.25 , 3.59]
Total (95% CI)		**781**		**771**	**100.0%**	**1.00 [0.75 , 1.32]**
Total events:	119		120			

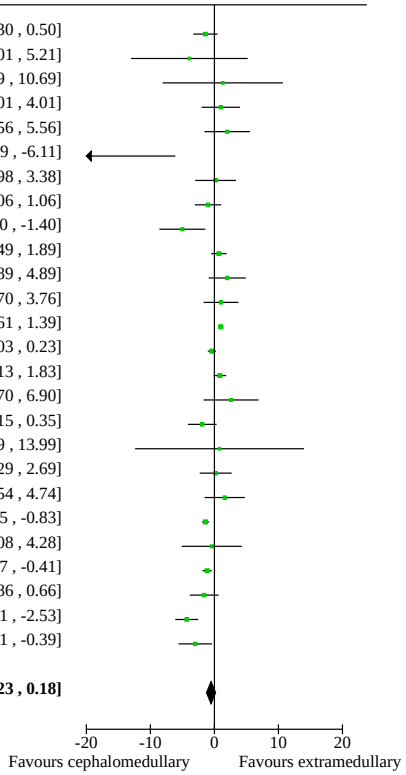
Heterogeneity: Tau² = 0.04; Chi² = 10.80, df = 8 (P = 0.21); I² = 26%
Test for overall effect: Z = 0.03 (P = 0.98)
Test for subgroup differences: Not applicable



Analysis 1.32. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 32: Length of hospital stay (days)

Study or Subgroup	Cephalomedullary nail Mean	SD	Total	Extramedullary implant Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Leung 1992	26.9	8.2	93	28.3	4.5	93	4.9%	-1.40 [-3.30 , 0.50]
O'Brien 1995	23.7	19	52	27.6	26.8	49	0.6%	-3.90 [-13.01 , 5.21]
Hoffman 1996	29.8	20.1	31	28.5	18.9	36	0.5%	1.30 [-8.09 , 10.69]
Kukla 1997	15.1	8.5	60	14.1	8.3	60	3.2%	1.00 [-2.01 , 4.01]
Baumgaertner 1998	13	14	67	11	5	68	2.6%	2.00 [-1.56 , 5.56]
Dujardin 2001	46	36	30	68	26	30	0.2%	-22.00 [-37.89 , -6.11]
Harrington 2002	16.5	8.8	50	16.3	7.5	52	3.0%	0.20 [-2.98 , 3.38]
Saudan 2002	13	4	100	14	10	106	4.7%	-1.00 [-3.06 , 1.06]
Sadowski 2002	13	4	20	18	7	19	2.6%	-5.00 [-8.60 , -1.40]
Pajarinen 2005	6.1	3.3	54	5.4	3	54	6.3%	0.70 [-0.49 , 1.89]
Ovesen 2006	16.4	8.4	73	14.4	9.4	73	3.4%	2.00 [-0.89 , 4.89]
Varela-Egocheaga 2009	12.8	6.22	40	11.77	6.22	40	3.6%	1.03 [-1.70 , 3.76]
Barton 2010	32	1.44	100	31	1.44	110	7.5%	1.00 [0.61 , 1.39]
Xu 2010	7	1.6	51	7.4	1.7	55	7.3%	-0.40 [-1.03 , 0.23]
Kouvidis 2012	9.01	3.16	86	8.16	3.24	79	6.7%	0.85 [-0.13 , 1.83]
Parker 2012	22.3	33	300	19.7	18.8	300	2.0%	2.60 [-1.70 , 6.90]
Tao 2013	18.4	4.1	45	20.3	6.3	42	4.3%	-1.90 [-4.15 , 0.35]
Gou 2013	8.2	45	45	7.4	3.6	45	0.3%	0.80 [-12.39 , 13.99]
Aktselis 2014	16.6	6.3	40	16.4	5	40	3.9%	0.20 [-2.29 , 2.69]
Chechik 2014	11.7	7.5	29	10.1	4.4	31	3.1%	1.60 [-1.54 , 4.74]
Zehir 2015	7.2	2.09	93	8.59	1.8	97	7.4%	-1.39 [-1.95 , -0.83]
Parker 2017	24.1	23.9	200	24.5	23.9	200	1.8%	-0.40 [-5.08 , 4.28]
Carulli 2017	6.91	1.63	66	8.05	2.46	62	7.1%	-1.14 [-1.87 , -0.41]
Singh 2017	11.2	3.2	23	12.8	4.4	22	4.3%	-1.60 [-3.86 , 0.66]
Xu 2018	20.22	4.12	50	24.54	4.98	50	5.1%	-4.32 [-6.11 , -2.53]
Chen 2018	13	4	18	16	4	18	3.7%	-3.00 [-5.61 , -0.39]
Total (95% CI)			**1816**			**1831**	**100.0%**	**-0.52 [-1.23 , 0.18]**

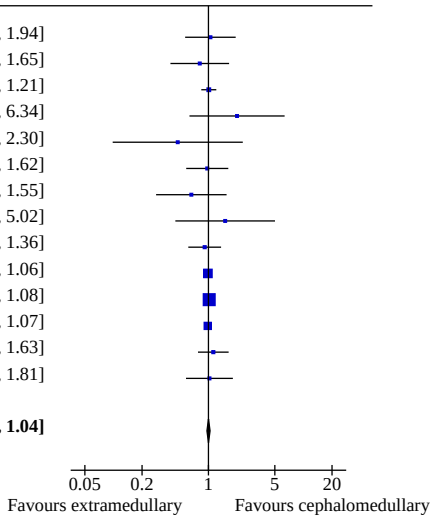
Heterogeneity: Tau² = 1.68; Chi² = 120.50, df = 25 (P < 0.00001); I² = 79%
Test for overall effect: Z = 1.46 (P = 0.15)
Test for subgroup differences: Not applicable



Analysis 1.33. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 33: Discharge destination (to own home/previous residence)

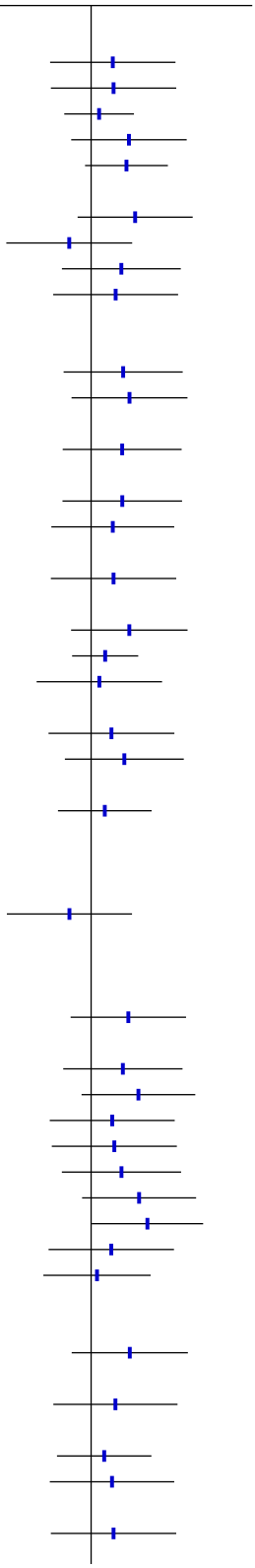
Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
Haynes 1996	9	19	14	31	0.4%	1.05 [0.57 , 1.94]
Baumgaertner 1998	11	64	14	66	0.3%	0.81 [0.40 , 1.65]
Hoffmann 1999	38	45	36	43	4.2%	1.01 [0.84 , 1.21]
Pelet 2001	6	13	3	13	0.1%	2.00 [0.63 , 6.34]
Sadowski 2002	2	20	4	19	0.1%	0.47 [0.10 , 2.30]
Saudan 2002	22	100	24	106	0.5%	0.97 [0.58 , 1.62]
Miedel 2005	8	109	12	108	0.2%	0.66 [0.28 , 1.55]
Pajarinen 2005	6	54	4	54	0.1%	1.50 [0.45 , 5.02]
Varela-Egocheaga 2009	21	40	23	40	0.9%	0.91 [0.61 , 1.36]
Parker 2012	248	300	251	300	27.1%	0.99 [0.92 , 1.06]
Zehir 2015	93	96	97	102	43.5%	1.02 [0.96 , 1.08]
Parker 2017	169	200	172	200	21.1%	0.98 [0.91 , 1.07]
Carulli 2017	20	29	19	31	1.0%	1.13 [0.78 , 1.63]
Sanders 2017	20	123	20	126	0.4%	1.02 [0.58 , 1.81]
Total (95% CI)		**1212**		**1239**	**100.0%**	**1.00 [0.96 , 1.04]**
Total events:	673		693			

Heterogeneity: Tau² = 0.00; Chi² = 5.63, df = 13 (P = 0.96); I² = 0%
Test for overall effect: Z = 0.07 (P = 0.95)
Test for subgroup differences: Not applicable



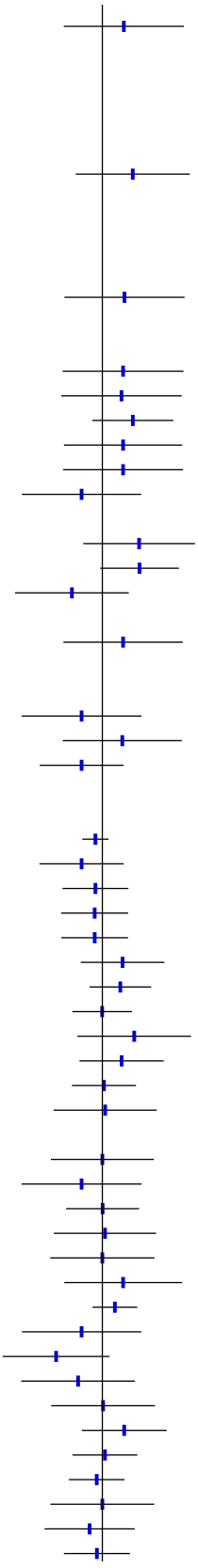
Analysis 1.34. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 34: Adverse event related to implant, fracture, or both

Study or Subgroup	Cephalomedullary nail Events	Total	Extramedullary implant Events	Total	Risk Ratio M-H, Random, 95% CI
1.34.1 Intra-operative periprosthetic fracture					
Guyer 1991	1	50	0	50	3.00 [0.13 , 71.92]
Bridle 1991	1	49	0	51	3.12 [0.13 , 74.80]
Leung 1992	3	93	2	93	1.50 [0.26 , 8.77]
Mott 1993	3	35	0	34	6.81 [0.36 , 127.00]
Radford 1993	6	100	1	100	6.00 [0.74 , 48.94]
Goldhagen 1994	0	36	0	39	Not estimable
Benum 1994	4	226	0	234	9.32 [0.50 , 172.07]
Ahrengart 1994	0	105	1	104	0.33 [0.01 , 8.01]
O'Brien 1995	2	53	0	49	4.63 [0.23 , 94.10]
Hoffman 1996	1	31	0	36	3.47 [0.15 , 82.21]
Kukla 1997	0	60	0	60	Not estimable
Kuwabara 1998	0	20	0	23	Not estimable
Baumgaertner 1998	2	67	0	68	5.07 [0.25 , 103.74]
Hardy 1998	3	50	0	50	7.00 [0.37 , 132.10]
Park 1998	0	30	0	30	Not estimable
Hoffmann 1999	2	56	0	54	4.82 [0.24 , 98.24]
Mehdi 2000	0	90	0	90	Not estimable
Adams 2001	2	203	0	197	4.85 [0.23 , 100.45]
Pelet 2001	1	13	0	13	3.00 [0.13 , 67.51]
Lopez 2002	0	43	0	60	Not estimable
Harrington 2002	1	50	0	52	3.12 [0.13 , 74.78]
Saudan 2002	0	100	0	106	Not estimable
Miedel 2005	3	109	0	108	6.94 [0.36 , 132.70]
Utrilla 2005	4	104	2	106	2.04 [0.38 , 10.89]
Papasimos 2005	1	80	0	40	1.52 [0.06 , 36.46]
Ovesen 2006	0	73	0	73	Not estimable
Ekstrom 2007	1	105	0	98	2.80 [0.12 , 67.98]
Xu 2010	2	51	0	55	5.38 [0.26 , 109.55]
Barton 2010	0	100	0	110	Not estimable
Verettas 2010	2	59	1	59	2.00 [0.19 , 21.46]
Hong 2011	0	10	0	10	Not estimable
Kouvidis 2012	0	86	0	79	Not estimable
Zhou 2012	0	36	0	28	Not estimable
Aktselis 2014	0	40	1	40	0.33 [0.01 , 7.95]
Sharma 2018	0	31	0	29	Not estimable
1.34.2 Postoperative periprosthetic fracture					
Bridle 1991	3	34	0	32	6.60 [0.35 , 122.96]
Guyer 1991	0	50	0	50	Not estimable
Leung 1992	2	93	0	93	5.00 [0.24 , 102.75]
Radford 1993	5	100	0	100	11.00 [0.62 , 196.33]
Mott 1993	1	35	0	34	2.92 [0.12 , 69.20]
Goldhagen 1994	1	36	0	39	3.24 [0.14 , 77.15]
Ahrengart 1994	2	87	0	81	4.66 [0.23 , 95.61]
Benum 1994	5	226	0	234	11.39 [0.63 , 204.76]
Butt 1995	8	47	0	48	17.35 [1.03 , 292.39]
O'Brien 1995	1	53	0	49	2.78 [0.12 , 66.62]
Hoffman 1996	1	23	1	31	1.35 [0.09 , 20.44]
Kukla 1997	0	45	0	44	Not estimable
Park 1998	0	30	0	30	Not estimable
Baumgaertner 1998	3	67	0	68	7.10 [0.37 , 134.92]
Hardy 1998	0	50	0	50	Not estimable
Kuwabara 1998	1	20	0	23	3.43 [0.15 , 79.74]
Hoffmann 1999	0	56	0	54	Not estimable
Adams 2001	2	203	1	197	1.94 [0.18 , 21.23]
Michos 2001	1	25	0	24	2.88 [0.12 , 67.53]
Lopez 2002	0	30	0	38	Not estimable
Harrington 2002	1	50	0	52	3.12 [0.13 , 74.78]
Pajarinen 2005	0	54	0	54	Not estimable



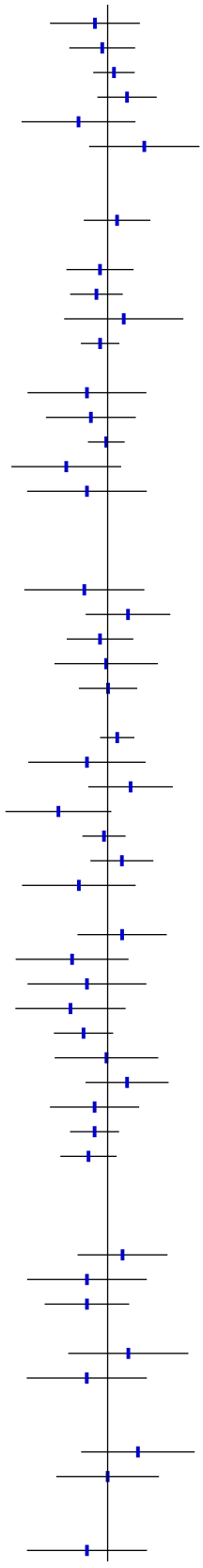
Analysis 1.34. (Continued)

Harrington 2002	1	50	0	52	3.12 [0.13 , 74.78]
Pajarinen 2005	0	54	0	54	Not estimable
Giraud 2005	0	34	0	26	Not estimable
Utrilla 2005	0	82	0	81	Not estimable
Papasimos 2005	0	80	0	40	Not estimable
Miedel 2005	0	109	0	108	Not estimable
Ovesen 2006	2	73	0	73	5.00 [0.24 , 102.38]
Ekstrom 2007	0	105	0	98	Not estimable
Little 2008	0	92	0	98	Not estimable
Zou 2009	0	58	0	63	Not estimable
Barton 2010	0	100	0	110	Not estimable
Xu 2010	1	51	0	55	3.23 [0.13 , 77.56]
Hong 2011	0	10	0	10	Not estimable
Zhou 2012	0	36	0	27	Not estimable
Parker 2012	1	300	0	300	3.00 [0.12 , 73.35]
Kouvidis 2012	1	86	0	79	2.76 [0.11 , 66.75]
Matre 2013	5	341	1	343	5.03 [0.59 , 42.82]
Calderon 2013	1	16	0	16	3.00 [0.13 , 68.57]
Gou 2013	1	45	0	45	3.00 [0.13 , 71.74]
Chechik 2014	0	26	1	26	0.33 [0.01 , 7.82]
Aktselis 2014	0	36	0	35	Not estimable
Parker 2017	3	200	0	200	7.00 [0.36 , 134.64]
Sanders 2017	7	123	1	126	7.17 [0.90 , 57.43]
Xu 2018	0	50	2	50	0.20 [0.01 , 4.06]
Sharma 2018	0	31	0	29	Not estimable
Singh 2019	1	30	0	30	3.00 [0.13 , 70.83]
1.34.3 Loosening of prosthesis					
Raimondo 2012	0	35	1	35	0.33 [0.01 , 7.91]
Singh 2017	1	23	0	22	2.88 [0.12 , 67.03]
Li 2018	1	40	3	40	0.33 [0.04 , 3.07]
1.34.4 Screw cut out					
Davis 1988	12	116	17	114	0.69 [0.35 , 1.39]
Guyer 1991	1	50	3	50	0.33 [0.04 , 3.10]
Bridle 1991	2	49	3	51	0.69 [0.12 , 3.98]
Leung 1992	2	113	3	113	0.67 [0.11 , 3.91]
Radford 1993	2	100	3	100	0.67 [0.11 , 3.90]
Mott 1993	3	35	1	34	2.91 [0.32 , 26.66]
Benum 1994	5	226	2	234	2.59 [0.51 , 13.21]
Ahrengart 1994	3	105	3	104	0.99 [0.20 , 4.80]
Goldhagen 1994	2	36	0	39	5.41 [0.27 , 108.93]
O'Brien 1995	3	53	1	49	2.77 [0.30 , 25.78]
Haynes 1996	2	19	3	31	1.09 [0.20 , 5.93]
Hoffman 1996	1	31	1	36	1.16 [0.08 , 17.80]
Kukla 1997	0	60	0	60	Not estimable
Park 1998	1	30	1	30	1.00 [0.07 , 15.26]
Hardy 1998	0	50	1	50	0.33 [0.01 , 7.99]
Baumgaertner 1998	2	67	2	68	1.01 [0.15 , 7.00]
Kuwabara 1998	1	20	1	23	1.15 [0.08 , 17.22]
Mehdi 2000	1	90	1	90	1.00 [0.06 , 15.74]
Pelet 2001	1	13	0	13	3.00 [0.13 , 67.51]
Adams 2001	8	203	4	197	1.94 [0.59 , 6.34]
Michos 2001	0	26	1	26	0.33 [0.01 , 7.82]
Sadowski 2002	0	20	5	19	0.09 [0.01 , 1.47]
Lopez 2002	0	43	2	60	0.28 [0.01 , 5.63]
Harrington 2002	1	50	1	52	1.04 [0.07 , 16.18]
Saudan 2002	3	100	1	106	3.18 [0.34 , 30.07]
Giraud 2005	3	34	2	26	1.15 [0.21 , 6.37]
Miedel 2005	3	109	4	108	0.74 [0.17 , 3.24]
Pajarinen 2005	1	54	1	54	1.00 [0.06 , 15.58]
Utrilla 2005	1	104	2	106	0.51 [0.05 , 5.53]
Papasimos 2005	3	80	2	40	0.75 [0.13 , 4.31]



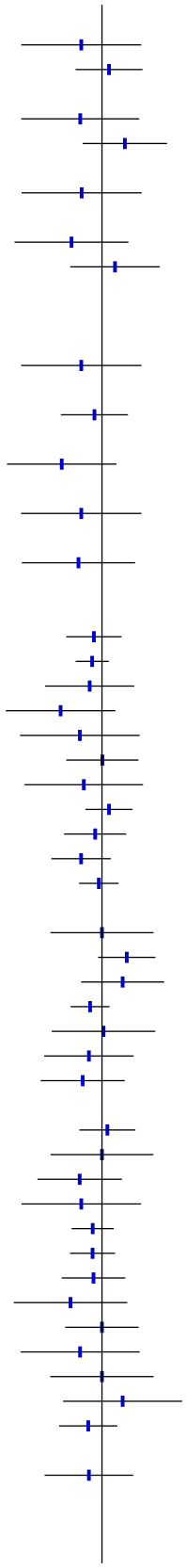
Analysis 1.34. (Continued)

Utrilla 2005	1	104	2	106	0.51 [0.05 , 5.53]
Papasimos 2005	3	80	2	40	0.75 [0.13 , 4.31]
Ovesen 2006	7	73	5	73	1.40 [0.47 , 4.21]
Ekstrom 2007	6	105	2	98	2.80 [0.58 , 13.55]
Little 2008	0	92	2	98	0.21 [0.01 , 4.38]
Varela-Egocheaga 2009	3	40	0	40	7.00 [0.37 , 131.28]
Zou 2009	0	58	0	63	Not estimable
Xu 2010	0	51	0	55	Not estimable
Barton 2010	3	100	2	110	1.65 [0.28 , 9.67]
Hong 2011	0	10	0	10	Not estimable
Parker 2012	2	300	3	300	0.67 [0.11 , 3.96]
Kouvidis 2012	3	86	5	79	0.55 [0.14 , 2.23]
Zhou 2012	1	36	0	28	2.35 [0.10 , 55.62]
Matre 2013	6	341	9	343	0.67 [0.24 , 1.86]
Aktselis 2014	0	36	0	35	Not estimable
Chechik 2014	0	26	1	26	0.33 [0.01 , 7.82]
Reindl 2015	1	112	2	92	0.41 [0.04 , 4.46]
Zehir 2015	7	96	8	102	0.93 [0.35 , 2.47]
Parker 2017	0	200	4	200	0.11 [0.01 , 2.05]
Xu 2018	0	50	1	50	0.33 [0.01 , 7.99]
Singh 2019	0	30	0	30	Not estimable
1.34.5 Implant failure					
Cai 2016	0	106	1	92	0.29 [0.01 , 7.03]
Davis 1988	3	116	1	114	2.95 [0.31 , 27.93]
Radford 1993	2	100	3	100	0.67 [0.11 , 3.90]
O'Brien 1995	1	53	1	49	0.92 [0.06 , 14.38]
Butt 1995	3	47	3	48	1.02 [0.22 , 4.81]
Kukla 1997	0	60	0	60	Not estimable
Adams 2001	12	203	7	197	1.66 [0.67 , 4.14]
Pelet 2001	0	13	1	13	0.33 [0.01 , 7.50]
Saudan 2002	3	79	1	89	3.38 [0.36 , 31.84]
Sadowski 2002	0	20	6	19	0.07 [0.00 , 1.22]
Utrilla 2005	5	82	6	81	0.82 [0.26 , 2.59]
Little 2008	4	92	2	98	2.13 [0.40 , 11.36]
Zou 2009	0	58	2	63	0.22 [0.01 , 4.43]
Barton 2010	0	100	0	110	Not estimable
Xu 2010	2	51	1	55	2.16 [0.20 , 23.07]
Zhou 2012	0	36	2	27	0.15 [0.01 , 3.03]
Chechik 2014	0	26	1	26	0.33 [0.01 , 7.82]
Aktselis 2014	0	36	3	35	0.14 [0.01 , 2.60]
Sanders 2017	2	102	6	85	0.28 [0.06 , 1.34]
Carulli 2017	1	66	1	62	0.94 [0.06 , 14.70]
Sharma 2018	3	31	1	29	2.81 [0.31 , 25.48]
Xu 2018	1	50	2	50	0.50 [0.05 , 5.34]
Adeel 2020	3	34	6	34	0.50 [0.14 , 1.84]
Andalib 2020	2	38	8	55	0.36 [0.08 , 1.61]
1.34.6 Deep infection					
Cai 2016	0	106	0	92	Not estimable
Davis 1988	2	107	1	118	2.21 [0.20 , 23.98]
Guyer 1991	0	50	1	50	0.33 [0.01 , 7.99]
Leung 1992	1	93	3	93	0.33 [0.04 , 3.15]
Mott 1993	0	35	0	34	Not estimable
Radford 1993	1	100	0	100	3.00 [0.12 , 72.77]
Ahrengart 1994	0	105	1	104	0.33 [0.01 , 8.01]
O'Brien 1995	0	53	0	49	Not estimable
Hoffman 1996	0	31	0	36	Not estimable
Kukla 1997	2	60	0	60	5.00 [0.25 , 102.00]
Park 1998	1	30	1	30	1.00 [0.07 , 15.26]
Hardy 1998	0	50	0	50	Not estimable
Hoffmann 1999	0	56	0	54	Not estimable
Mehdi 2000	0	90	1	90	0.33 [0.01 , 8.08]



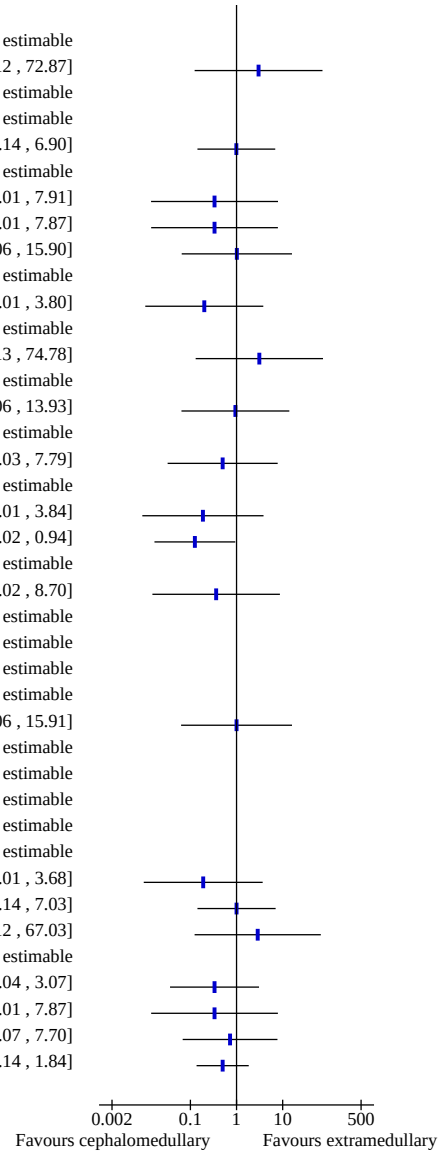
Analysis 1.34. (Continued)

Hoffmann 1999	0	56	0	54	Not estimable
Mehdi 2000	0	90	1	90	0.33 [0.01 , 8.08]
Adams 2001	3	203	2	197	1.46 [0.25 , 8.62]
Pelet 2001	0	13	0	13	Not estimable
Sadowski 2002	0	18	1	17	0.32 [0.01 , 7.26]
Saudan 2002	3	79	1	89	3.38 [0.36 , 31.84]
Pajarinen 2005	0	54	0	54	Not estimable
Utrilla 2005	0	104	1	106	0.34 [0.01 , 8.24]
Giraud 2005	0	34	0	26	Not estimable
Miedel 2005	0	109	2	108	0.20 [0.01 , 4.08]
Ovesen 2006	2	73	1	73	2.00 [0.19 , 21.58]
Little 2008	0	92	0	98	Not estimable
Zou 2009	0	58	0	63	Not estimable
Barton 2010	0	100	0	110	Not estimable
Parker 2012	0	300	1	300	0.33 [0.01 , 8.15]
Zhou 2012	0	36	0	27	Not estimable
Matre 2013	2	341	3	343	0.67 [0.11 , 3.99]
Aktselis 2014	0	40	0	40	Not estimable
Zehir 2015	0	96	4	102	0.12 [0.01 , 2.16]
Reindl 2015	0	112	0	92	Not estimable
Parker 2017	0	200	1	200	0.33 [0.01 , 8.13]
Singh 2017	0	23	0	22	Not estimable
Andalib 2020	0	38	2	55	0.29 [0.01 , 5.82]
1.34.7 Superficial infection					
Cai 2016	3	106	4	92	0.65 [0.15 , 2.83]
Davis 1988	7	107	13	118	0.59 [0.25 , 1.43]
Bridle 1991	1	49	2	51	0.52 [0.05 , 5.56]
Radford 1993	0	100	4	100	0.11 [0.01 , 2.04]
O'Brien 1995	0	53	1	49	0.31 [0.01 , 7.40]
Butt 1995	2	47	2	48	1.02 [0.15 , 6.95]
Kuwabara 1998	0	20	1	23	0.38 [0.02 , 8.86]
Adams 2001	6	203	4	197	1.46 [0.42 , 5.08]
Lopez 2002	2	43	4	60	0.70 [0.13 , 3.64]
Miedel 2005	2	109	6	108	0.33 [0.07 , 1.60]
Utrilla 2005	6	82	7	81	0.85 [0.30 , 2.41]
Pajarinen 2005	0	54	0	54	Not estimable
Papasimos 2005	1	40	1	40	1.00 [0.06 , 15.44]
Ekstrom 2007	8	105	2	98	3.73 [0.81 , 17.15]
Rahme 2007	3	29	1	29	3.00 [0.33 , 27.18]
Little 2008	5	92	10	98	0.53 [0.19 , 1.50]
Zou 2009	1	58	1	63	1.09 [0.07 , 16.97]
Verettas 2010	1	59	2	59	0.50 [0.05 , 5.37]
Xu 2010	1	51	3	55	0.36 [0.04 , 3.35]
Zhou 2012	0	36	0	28	Not estimable
Parker 2012	4	300	3	300	1.33 [0.30 , 5.91]
Raimondo 2012	1	35	1	35	1.00 [0.07 , 15.36]
Kouvidis 2012	1	86	3	79	0.31 [0.03 , 2.88]
Gou 2013	0	45	1	45	0.33 [0.01 , 7.97]
Chechik 2014	4	29	7	31	0.61 [0.20 , 1.87]
Zehir 2015	4	96	7	102	0.61 [0.18 , 2.01]
Singh 2017	2	23	3	22	0.64 [0.12 , 3.46]
Carulli 2017	0	66	2	62	0.19 [0.01 , 3.84]
Parker 2017	2	200	2	200	1.00 [0.14 , 7.03]
Sharma 2018	0	31	1	29	0.31 [0.01 , 7.38]
Xu 2018	1	50	1	50	1.00 [0.06 , 15.55]
Singh 2019	1	30	0	30	3.00 [0.13 , 70.83]
Andalib 2020	2	38	6	55	0.48 [0.10 , 2.26]
Eceviz 2020	0	29	0	27	Not estimable
Adeel 2020	1	34	2	34	0.50 [0.05 , 5.26]
1.34.8 Non-union					
Cai 2016	0	106	0	92	Not estimable



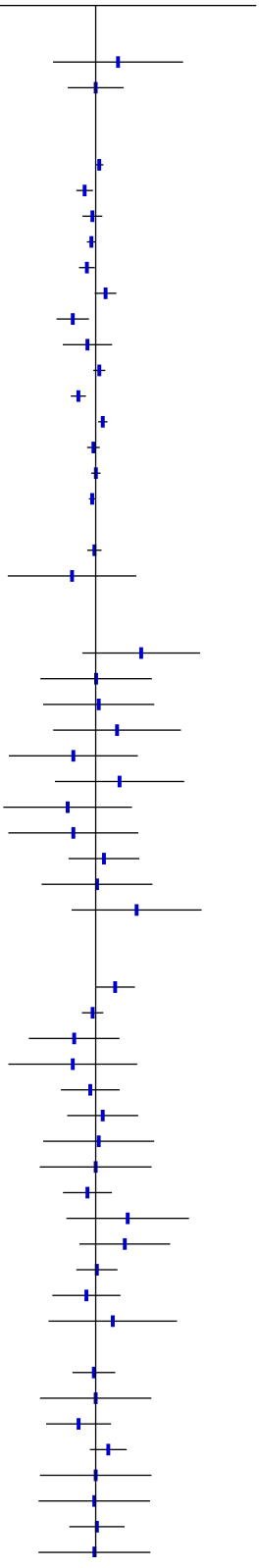
Analysis 1.34. (Continued)

1.34.8 Non-union					
Cai 2016	0	106	0	92	Not estimable
Leung 1992	1	113	0	113	3.00 [0.12 , 72.87]
Radford 1993	0	100	0	100	Not estimable
Goldhagen 1994	0	36	0	39	Not estimable
Ahrengart 1994	2	105	2	104	0.99 [0.14 , 6.90]
Kukla 1997	0	60	0	60	Not estimable
Hardy 1998	0	35	1	35	0.33 [0.01 , 7.91]
Park 1998	0	30	1	30	0.33 [0.01 , 7.87]
Baumgaertner 1998	1	67	1	68	1.01 [0.06 , 15.90]
Dujardin 2001	0	30	0	30	Not estimable
Pelet 2001	0	13	2	13	0.20 [0.01 , 3.80]
Michos 2001	0	26	0	26	Not estimable
Harrington 2002	1	50	0	52	3.12 [0.13 , 74.78]
Saudan 2002	0	100	0	106	Not estimable
Sadowski 2002	1	18	1	17	0.94 [0.06 , 13.93]
Giraud 2005	0	34	0	26	Not estimable
Papasimos 2005	1	80	1	40	0.50 [0.03 , 7.79]
Ovesen 2006	0	73	0	73	Not estimable
Ekstrom 2007	0	105	2	98	0.19 [0.01 , 3.84]
Rahme 2007	1	30	8	30	0.13 [0.02 , 0.94]
Little 2008	0	92	0	98	Not estimable
Zou 2009	0	58	1	63	0.36 [0.02 , 8.70]
Barton 2010	0	100	0	110	Not estimable
Xu 2010	0	51	0	55	Not estimable
Hong 2011	0	10	0	10	Not estimable
Kouvidis 2012	0	86	0	79	Not estimable
Parker 2012	1	300	1	300	1.00 [0.06 , 15.91]
Zhou 2012	0	36	0	27	Not estimable
Gou 2013	0	45	0	45	Not estimable
Tao 2013	0	45	0	42	Not estimable
Calderon 2013	0	16	0	16	Not estimable
Aktselis 2014	0	36	0	35	Not estimable
Haq 2014	0	18	2	17	0.19 [0.01 , 3.68]
Parker 2017	2	200	2	200	1.00 [0.14 , 7.03]
Singh 2017	1	23	0	22	2.88 [0.12 , 67.03]
Sharma 2018	0	31	0	29	Not estimable
Li 2018	1	40	3	40	0.33 [0.04 , 3.07]
Singh 2019	0	30	1	30	0.33 [0.01 , 7.87]
Andalib 2020	1	38	2	55	0.72 [0.07 , 7.70]
Adeel 2020	3	34	6	34	0.50 [0.14 , 1.84]



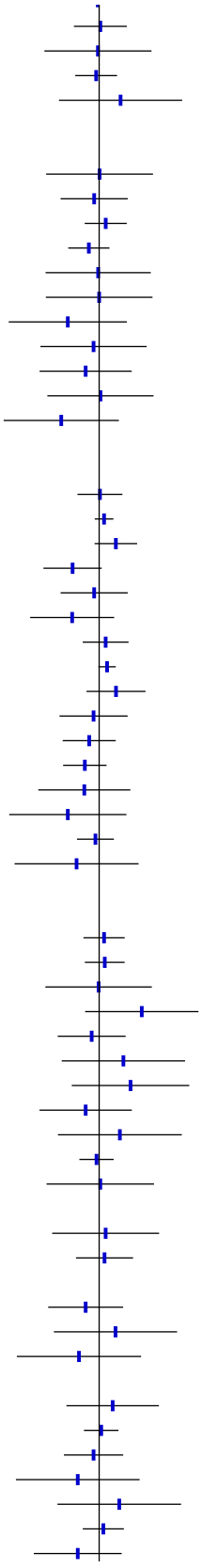
Analysis 1.35. Comparison 1: Cephalomedullary nails versus extramedullary implants, Outcome 35: Adverse events unrelated to implant, fracture, or both

Study or Subgroup	Cephalomedullary nail Events	Total	Extramedullary implant Events	Total	Risk Ratio M-H, Random, 95% CI
1.35.1 Acute kidney injury					
Parker 2012	1	300	0	300	3.00 [0.12 , 73.35]
Parker 2017	4	200	4	200	1.00 [0.25 , 3.94]
1.35.2 Blood transfusion					
Adams 2001	108	203	88	197	1.19 [0.97 , 1.46]
Sadowski 2002	11	20	18	19	0.58 [0.39 , 0.88]
Harrington 2002	18	50	22	52	0.85 [0.52 , 1.39]
Saudan 2002	55	100	72	106	0.81 [0.65 , 1.01]
Utrilla 2005	28	104	44	106	0.65 [0.44 , 0.96]
Ovesen 2006	26	73	16	73	1.63 [0.95 , 2.77]
Little 2008	7	92	23	98	0.32 [0.15 , 0.72]
Verettas 2010	4	60	6	60	0.67 [0.20 , 2.24]
Barton 2010	50	100	46	110	1.20 [0.89 , 1.61]
Xu 2010	19	51	48	55	0.43 [0.29 , 0.62]
Raimondo 2012	34	35	24	35	1.42 [1.12 , 1.79]
Kouvidis 2012	40	86	41	79	0.90 [0.66 , 1.22]
Parker 2012	100	300	99	300	1.01 [0.80 , 1.27]
Matre 2013	143	341	171	343	0.84 [0.71 , 0.99]
Yamauchi 2014	0	10	0	8	Not estimable
Parker 2017	46	200	49	200	0.94 [0.66 , 1.33]
Sharma 2018	0	31	1	29	0.31 [0.01 , 7.38]
1.35.3 Cerebrovascular accident					
Bridle 1991	4	49	0	51	9.36 [0.52 , 169.40]
Butt 1995	1	47	1	48	1.02 [0.07 , 15.86]
Hoffman 1996	1	31	1	36	1.16 [0.08 , 17.80]
Sadowski 2002	1	20	0	19	2.86 [0.12 , 66.11]
Varela-Egocheaga 2009	0	40	1	40	0.33 [0.01 , 7.95]
Xu 2010	1	51	0	55	3.23 [0.13 , 77.56]
Zhou 2012	0	36	1	27	0.25 [0.01 , 5.96]
Parker 2012	0	300	1	300	0.33 [0.01 , 8.15]
Gou 2013	3	45	2	45	1.50 [0.26 , 8.55]
Chechik 2014	1	29	1	31	1.07 [0.07 , 16.31]
Parker 2017	1	200	0	500	7.48 [0.31 , 182.79]
1.35.4 Chest infection/pneumonia					
Cai 2016	15	106	5	92	2.60 [0.98 , 6.89]
Davis 1988	21	116	24	114	0.86 [0.51 , 1.45]
Bridle 1991	1	49	3	51	0.35 [0.04 , 3.22]
Mott 1993	0	35	1	34	0.32 [0.01 , 7.69]
Butt 1995	3	47	4	48	0.77 [0.18 , 3.24]
O'Brien 1995	3	52	2	49	1.41 [0.25 , 8.10]
Hoffman 1996	1	31	1	36	1.16 [0.08 , 17.80]
Kukla 1997	1	60	1	60	1.00 [0.06 , 15.62]
Hardy 1998	4	50	6	50	0.67 [0.20 , 2.22]
Hoffmann 1999	2	56	0	54	4.82 [0.24 , 98.24]
Lopez 2002	3	43	1	60	4.19 [0.45 , 38.89]
Saudan 2002	7	100	7	106	1.06 [0.39 , 2.91]
Sadowski 2002	2	20	3	19	0.63 [0.12 , 3.38]
Giraud 2005	1	34	0	26	2.31 [0.10 , 54.60]
Papasimos 2005	0	80	0	40	Not estimable
Little 2008	6	92	7	98	0.91 [0.32 , 2.62]
Varela-Egocheaga 2009	1	40	1	40	1.00 [0.06 , 15.44]
Xu 2010	2	51	5	55	0.43 [0.09 , 2.13]
Parker 2012	13	300	7	300	1.86 [0.75 , 4.59]
Gou 2013	1	45	1	45	1.00 [0.06 , 15.50]
Tao 2013	1	45	1	42	0.93 [0.06 , 14.45]
Zehir 2015	4	96	4	102	1.06 [0.27 , 4.13]
Carulli 2017	1	66	1	62	0.94 [0.06 , 14.70]



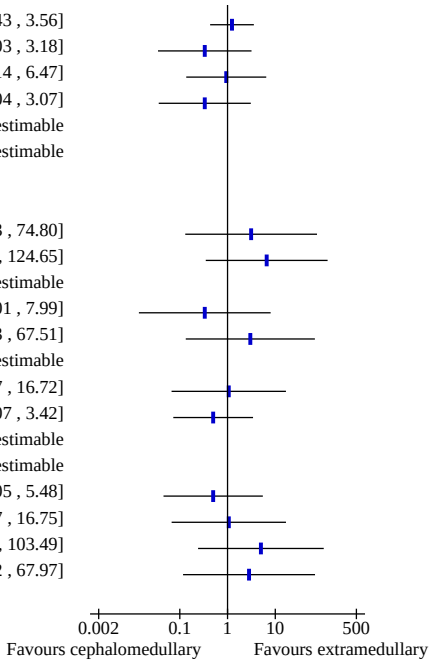
Analysis 1.35. (Continued)

Zehir 2015	4	96	4	102	1.06 [0.27 , 4.13]
Carulli 2017	1	66	1	62	0.94 [0.06 , 14.70]
Parker 2017	6	200	7	200	0.86 [0.29 , 2.51]
Singh 2019	1	30	0	30	3.00 [0.13 , 70.83]
1.35.5 Myocardial infarction/acute coronary syndrome					
Butt 1995	1	47	1	48	1.02 [0.07 , 15.86]
Hoffman 1996	2	31	3	36	0.77 [0.14 , 4.34]
Hardy 1998	7	50	5	50	1.40 [0.48 , 4.12]
Saudan 2002	5	100	9	106	0.59 [0.20 , 1.70]
Sadowski 2002	1	20	1	19	0.95 [0.06 , 14.13]
Varela-Egocheaga 2009	1	40	1	40	1.00 [0.06 , 15.44]
Parker 2012	0	300	2	300	0.20 [0.01 , 4.15]
Zhou 2012	1	36	1	27	0.75 [0.05 , 11.46]
Gou 2013	1	45	2	45	0.50 [0.05 , 5.32]
Chechik 2014	1	29	1	31	1.07 [0.07 , 16.31]
Parker 2017	0	200	3	200	0.14 [0.01 , 2.75]
1.35.6 Urinary tract infection					
Cai 2016	6	106	5	92	1.04 [0.33 , 3.30]
Davis 1988	28	107	24	118	1.29 [0.80 , 2.08]
O'Brien 1995	10	52	4	49	2.36 [0.79 , 7.02]
Butt 1995	2	47	8	48	0.26 [0.06 , 1.14]
Hoffman 1996	2	31	3	36	0.77 [0.14 , 4.34]
Hardy 1998	1	50	4	50	0.25 [0.03 , 2.16]
Lopez 2002	5	43	5	60	1.40 [0.43 , 4.52]
Saudan 2002	34	100	24	106	1.50 [0.96 , 2.34]
Sadowski 2002	5	20	2	19	2.38 [0.52 , 10.80]
Papasimos 2005	3	80	2	40	0.75 [0.13 , 4.31]
Varela-Egocheaga 2009	3	40	5	40	0.60 [0.15 , 2.34]
Xu 2010	4	51	9	55	0.48 [0.16 , 1.46]
Tao 2013	1	45	2	42	0.47 [0.04 , 4.96]
Gou 2013	0	45	2	45	0.20 [0.01 , 4.05]
Zehir 2015	7	96	9	102	0.83 [0.32 , 2.13]
Carulli 2017	0	66	1	62	0.31 [0.01 , 7.55]
1.35.7 Venous thromboembolic phenomena (DVT)					
Davis 1988	7	107	6	118	1.29 [0.45 , 3.71]
Radford 1993	8	100	6	100	1.33 [0.48 , 3.70]
Mott 1993	1	35	1	34	0.97 [0.06 , 14.91]
Ahrengart 1994	4	105	0	104	8.92 [0.49 , 163.53]
Butt 1995	2	47	3	48	0.68 [0.12 , 3.89]
Hoffman 1996	1	31	0	36	3.47 [0.15 , 82.21]
Kukla 1997	2	60	0	60	5.00 [0.25 , 102.00]
Hardy 1998	1	50	2	50	0.50 [0.05 , 5.34]
Hoffmann 1999	1	56	0	54	2.89 [0.12 , 69.55]
Adams 2001	9	203	10	197	0.87 [0.36 , 2.10]
Saudan 2002	1	100	1	106	1.06 [0.07 , 16.72]
Sadowski 2002	0	20	0	19	Not estimable
Lopez 2002	1	43	1	60	1.40 [0.09 , 21.70]
Utrilla 2005	4	82	3	81	1.32 [0.30 , 5.70]
Pajarinen 2005	0	54	0	54	Not estimable
Papasimos 2005	2	80	2	40	0.50 [0.07 , 3.42]
Giraud 2005	1	34	0	26	2.31 [0.10 , 54.60]
Little 2008	0	92	1	98	0.35 [0.01 , 8.60]
Zou 2009	0	58	0	63	Not estimable
Verettas 2010	2	59	1	59	2.00 [0.19 , 21.46]
Parker 2012	10	300	9	300	1.11 [0.46 , 2.70]
Zhou 2012	3	36	3	27	0.75 [0.16 , 3.43]
Gou 2013	0	45	1	45	0.33 [0.01 , 7.97]
Tao 2013	1	45	0	42	2.80 [0.12 , 67.00]
Zehir 2015	7	96	6	102	1.24 [0.43 , 3.56]
Parker 2017	1	200	3	200	0.33 [0.03 , 3.18]



Analysis 1.35. (Continued)

Zehir 2015	7	96	6	102	1.24 [0.43 , 3.56]
Parker 2017	1	200	3	200	0.33 [0.03 , 3.18]
Carulli 2017	2	66	2	62	0.94 [0.14 , 6.47]
Li 2018	1	40	3	40	0.33 [0.04 , 3.07]
Sharma 2018	0	31	0	29	Not estimable
Singh 2019	0	30	0	30	Not estimable
1.35.8 Venous thromboembolic phenomena (PE)					
Bridle 1991	1	49	0	51	3.12 [0.13 , 74.80]
O'Brien 1995	3	52	0	49	6.60 [0.35 , 124.65]
Kukla 1997	0	60	0	60	Not estimable
Hardy 1998	0	50	1	50	0.33 [0.01 , 7.99]
Pelet 2001	1	13	0	13	3.00 [0.13 , 67.51]
Sadowski 2002	0	20	0	19	Not estimable
Saudan 2002	1	100	1	106	1.06 [0.07 , 16.72]
Papasimos 2005	2	80	2	40	0.50 [0.07 , 3.42]
Little 2008	0	92	0	98	Not estimable
Xu 2010	0	51	0	55	Not estimable
Parker 2012	1	300	2	300	0.50 [0.05 , 5.48]
Zehir 2015	1	96	1	102	1.06 [0.07 , 16.75]
Parker 2017	2	200	0	200	5.00 [0.24 , 103.49]
Carulli 2017	1	66	0	62	2.82 [0.12 , 67.97]



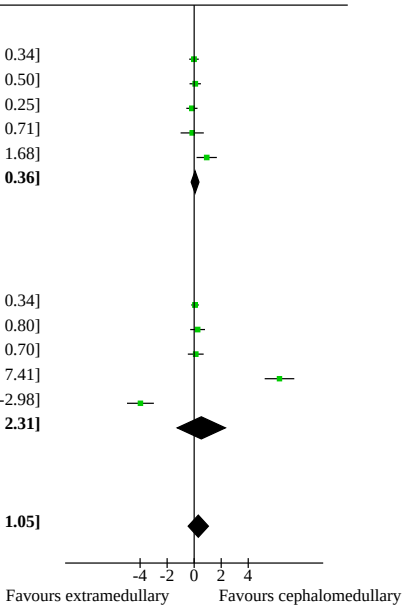
Comparison 2. Cephalomedullary nails versus extramedullary implants: subgrouped by short or long intramedullary nails

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.1 Functional status at 12 months (mean scores)	10	775	Std. Mean Difference (IV, Random, 95% CI)	0.31 [-0.44, 1.05]
2.1.1 Short nail	5	351	Std. Mean Difference (IV, Random, 95% CI)	0.07 [-0.22, 0.36]
2.1.2 Unknown nail lengths	5	424	Std. Mean Difference (IV, Random, 95% CI)	0.53 [-1.25, 2.31]
2.2 Mobility at 12 months (mobility scales, mean scores)	14	1746	Mean Difference (IV, Random, 95% CI)	0.48 [0.10, 0.87]
2.2.1 Short nail	11	1493	Mean Difference (IV, Random, 95% CI)	0.34 [0.02, 0.65]
2.2.2 Long nail	1	156	Mean Difference (IV, Random, 95% CI)	2.10 [1.32, 2.88]
2.2.3 Unknown nail length	2	97	Mean Difference (IV, Random, 95% CI)	0.26 [-0.67, 1.20]
2.3 Mobility (12 months; independent mobility)	12	1524	Risk Ratio (M-H, Random, 95% CI)	1.07 [0.94, 1.22]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.3.1 Short nail	10	1455	Risk Ratio (M-H, Random, 95% CI)	1.07 [0.94, 1.21]
2.3.2 Mixed or unknown nail length	2	69	Risk Ratio (M-H, Random, 95% CI)	1.17 [0.33, 4.16]
2.4 Early mortality	30	4603	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.79, 1.18]
2.4.1 Short nail	22	2953	Risk Ratio (M-H, Random, 95% CI)	0.95 [0.76, 1.20]
2.4.2 Long nail	2	400	Risk Ratio (M-H, Random, 95% CI)	1.80 [1.02, 3.18]
2.4.3 Mixed or unknown nail lengths	6	1250	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.36, 1.14]
2.5 Mortality at 12 months	47	7618	Risk Ratio (M-H, Random, 95% CI)	0.99 [0.90, 1.08]
2.5.1 Short nail	34	5374	Risk Ratio (M-H, Random, 95% CI)	0.97 [0.87, 1.08]
2.5.2 Long nail	2	400	Risk Ratio (M-H, Random, 95% CI)	1.28 [0.89, 1.85]
2.5.3 Mixed or unknown nail lengths	11	1844	Risk Ratio (M-H, Random, 95% CI)	0.98 [0.82, 1.16]
2.6 Unplanned return to theatre	50	8398	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.89, 1.50]
2.6.1 Short nail	36	6266	Risk Ratio (M-H, Random, 95% CI)	1.12 [0.79, 1.57]
2.6.2 Long nail	2	400	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.24, 5.40]
2.6.3 Mixed and unknown nail lengths	12	1732	Risk Ratio (M-H, Random, 95% CI)	1.16 [0.81, 1.67]

Analysis 2.1. Comparison 2: Cephalomedullary nails versus extramedullary implants: subgrouped by short or long intramedullary nails, Outcome 1: Functional status at 12 months (mean scores)

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
2.1.1 Short nail								
Kouvidis 2012 (1)	74.33	25.19	62	74.66	21.21	60	10.6%	-0.01 [-0.37 , 0.34]
Tao 2013 (2)	82.8	9.5	45	82	10.4	42	10.5%	0.08 [-0.34 , 0.50]
Gou 2013 (3)	22.8	7	45	24	7.2	45	10.5%	-0.17 [-0.58 , 0.25]
Guerra 2014 (4)	33.8	7.11	10	35.09	9.61	11	9.5%	-0.15 [-1.00 , 0.71]
Haq 2014 (5)	81.53	13.21	17	68.43	14.36	14	9.8%	0.93 [0.18 , 1.68]
Subtotal (95% CI)			**179**			**172**	**50.9%**	**0.07 [-0.22 , 0.36]**
Heterogeneity: Tau² = 0.04; Chi² = 6.67, df = 4 (P = 0.15); I² = 40%								
Test for overall effect: Z = 0.46 (P = 0.65)								
2.1.2 Unknown nail lengths								
Cai 2016 (6)	36.1	2.38	106	35.96	1.99	92	10.7%	0.06 [-0.22 , 0.34]
Chechik 2014 (5)	67	15	26	63	16	26	10.3%	0.25 [-0.29 , 0.80]
Singh 2017 (7)	82.8	10.5	23	81	18.8	22	10.2%	0.12 [-0.47 , 0.70]
Li 2018 (5)	85.3	2.4	40	72.3	1.6	40	8.8%	6.31 [5.22 , 7.41]
Singh 2019 (8)	79.73	1.2	24	85.46	1.6	25	9.1%	-3.97 [-4.97 , -2.98]
Subtotal (95% CI)			**219**			**205**	**49.1%**	**0.53 [-1.25 , 2.31]**
Heterogeneity: Tau² = 3.98; Chi² = 188.47, df = 4 (P < 0.00001); I² = 98%								
Test for overall effect: Z = 0.58 (P = 0.56)								
Total (95% CI)			**398**			**377**	**100.0%**	**0.31 [-0.44 , 1.05]**
Heterogeneity: Tau² = 1.34; Chi² = 195.73, df = 9 (P < 0.00001); I² = 95%								
Test for overall effect: Z = 0.80 (P = 0.42)								
Test for subgroup differences: Chi² = 0.25, df = 1 (P = 0.62), I² = 0%								

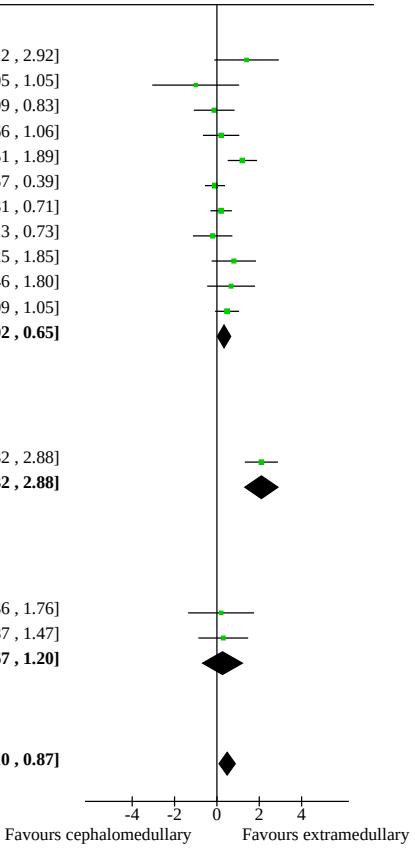


Footnotes

(1) Functional recovery score (0 to 100; higher scores indicate better function)
(2) Modified HHS
(3) OHS (range 0 to 48, higher scores indicate better function)
(4) Zuckerman (0 to 44; higher scores indicate better function)
(5) HHS (higher scores indicate better function)
(6) Zűckerman (0 to 44; higher scores indicate better function)
(7) HHS (higher scores indicate better function); PFN vs locking compression plate; at 24 months
(8) modified HHS (higher scores indicate better function); PFN vs DHS; at 12 months

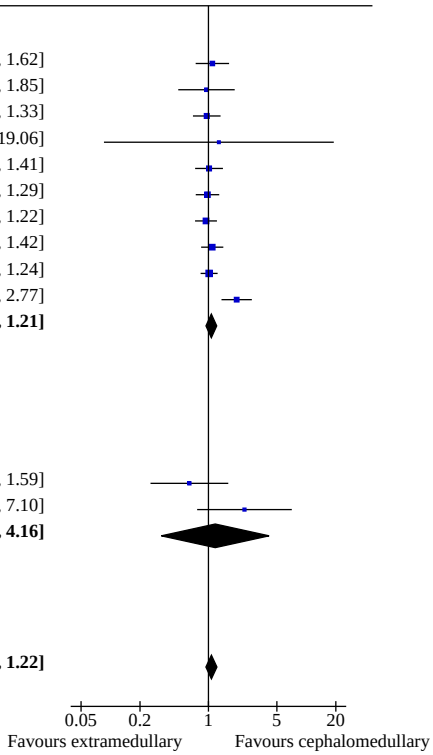
Analysis 2.2. Comparison 2: Cephalomedullary nails versus extramedullary implants: subgrouped by short or long intramedullary nails, Outcome 2: Mobility at 12 months (mobility scales, mean scores)

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
2.2.1 Short nail								
Hardy 1998	4.8	3.2	35	3.4	3.3	35	4.2%	1.40 [-0.12 , 2.92]
Sadowski 2002	5	2.6	18	6	3.5	17	2.7%	-1.00 [-3.05 , 1.05]
Saudan 2002	4.94	3.33	79	5.07	2.97	89	7.1%	-0.13 [-1.09 , 0.83]
Utrilla 2005	6.4	2.8	82	6.2	2.79	81	7.8%	0.20 [-0.66 , 1.06]
Xu 2010	5.6	1.4	40	4.4	1.8	43	9.0%	1.20 [0.51 , 1.89]
Han 2012	7.59	1.12	41	7.68	1.09	42	10.7%	-0.09 [-0.57 , 0.39]
Parker 2012	4.84	2.7	209	4.64	2.6	213	10.5%	0.20 [-0.31 , 0.71]
Gou 2013	6.7	2.8	45	6.9	1.5	45	7.3%	-0.20 [-1.13 , 0.73]
Aktselis 2014	6.5	2.3	36	5.7	2.2	35	6.5%	0.80 [-0.25 , 1.85]
Haq 2014	7.53	1.807	17	6.86	1.4	14	6.0%	0.67 [-0.46 , 1.80]
Parker 2017	5.95	2.5	139	5.47	2.3	138	10.0%	0.48 [-0.09 , 1.05]
Subtotal (95% CI)			**741**			**752**	**81.8%**	**0.34 [0.02 , 0.65]**
Heterogeneity: Tau² = 0.10; Chi² = 16.41, df = 10 (P = 0.09); I² = 39%								
Test for overall effect: Z = 2.10 (P = 0.04)								
2.2.2 Long nail								
Little 2008	5.9	2.67	76	3.8	2.28	80	8.3%	2.10 [1.32 , 2.88]
Subtotal (95% CI)			**76**			**80**	**8.3%**	**2.10 [1.32 , 2.88]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 5.27 (P < 0.00001)								
2.2.3 Unknown nail length								
Chechik 2014	4.3	3.1	26	4.1	2.6	26	4.1%	0.20 [-1.36 , 1.76]
Singh 2017	6.3	2.1	23	6	1.92	22	5.8%	0.30 [-0.87 , 1.47]
Subtotal (95% CI)			**49**			**48**	**9.9%**	**0.26 [-0.67 , 1.20]**
Heterogeneity: Tau² = 0.00; Chi² = 0.01, df = 1 (P = 0.92); I² = 0%								
Test for overall effect: Z = 0.55 (P = 0.58)								
Total (95% CI)			**866**			**880**	**100.0%**	**0.48 [0.10 , 0.87]**
Heterogeneity: Tau² = 0.30; Chi² = 35.31, df = 13 (P = 0.0008); I² = 63%								
Test for overall effect: Z = 2.49 (P = 0.01)								
Test for subgroup differences: Chi² = 17.26, df = 2 (P = 0.0002), I² = 88.4%								



Analysis 2.3. Comparison 2: Cephalomedullary nails versus extramedullary implants: subgrouped by short or long intramedullary nails, Outcome 3: Mobility (12 months; independent mobility)

Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
2.3.1 Short nail						
Leung 1992	34	93	31	93	7.9%	1.10 [0.74 , 1.62]
Goldhagen 1994	10	29	13	36	3.4%	0.95 [0.49 , 1.85]
Ahrengart 1994 (1)	49	169	54	179	10.2%	0.96 [0.69 , 1.33]
Haynes 1996	1	18	1	23	0.2%	1.28 [0.09 , 19.06]
Kukla 1997 (2)	28	45	27	44	10.1%	1.01 [0.73 , 1.41]
Adams 2001	56	126	55	121	12.4%	0.98 [0.74 , 1.29]
Ekstrom 2007	41	64	38	56	13.4%	0.94 [0.73 , 1.22]
Varela-Egocheaga 2009 (3)	30	38	26	36	13.2%	1.09 [0.84 , 1.42]
Tao 2013	37	45	34	42	17.0%	1.02 [0.83 , 1.24]
Zehir 2015	53	96	29	102	9.0%	1.94 [1.36 , 2.77]
Subtotal (95% CI)		**723**		**732**	**96.8%**	**1.07 [0.94 , 1.21]**
Total events:	339		308			
Heterogeneity: Tau² = 0.01; Chi² = 13.22, df = 9 (P = 0.15); I² = 32%						
Test for overall effect: Z = 1.06 (P = 0.29)						
2.3.2 Mixed or unknown nail length						
Kuwabara 1998 (4)	5	20	9	23	1.9%	0.64 [0.26 , 1.59]
Pelet 2001 (5)	7	13	3	13	1.3%	2.33 [0.77 , 7.10]
Subtotal (95% CI)		**33**		**36**	**3.2%**	**1.17 [0.33 , 4.16]**
Total events:	12		12			
Heterogeneity: Tau² = 0.57; Chi² = 3.11, df = 1 (P = 0.08); I² = 68%						
Test for overall effect: Z = 0.25 (P = 0.81)						
Total (95% CI)		**756**		**768**	**100.0%**	**1.07 [0.94 , 1.22]**
Total events:	351		320			
Heterogeneity: Tau² = 0.02; Chi² = 16.33, df = 11 (P = 0.13); I² = 33%						
Test for overall effect: Z = 1.06 (P = 0.29)						
Test for subgroup differences: Chi² = 0.02, df = 1 (P = 0.89), I² = 0%						

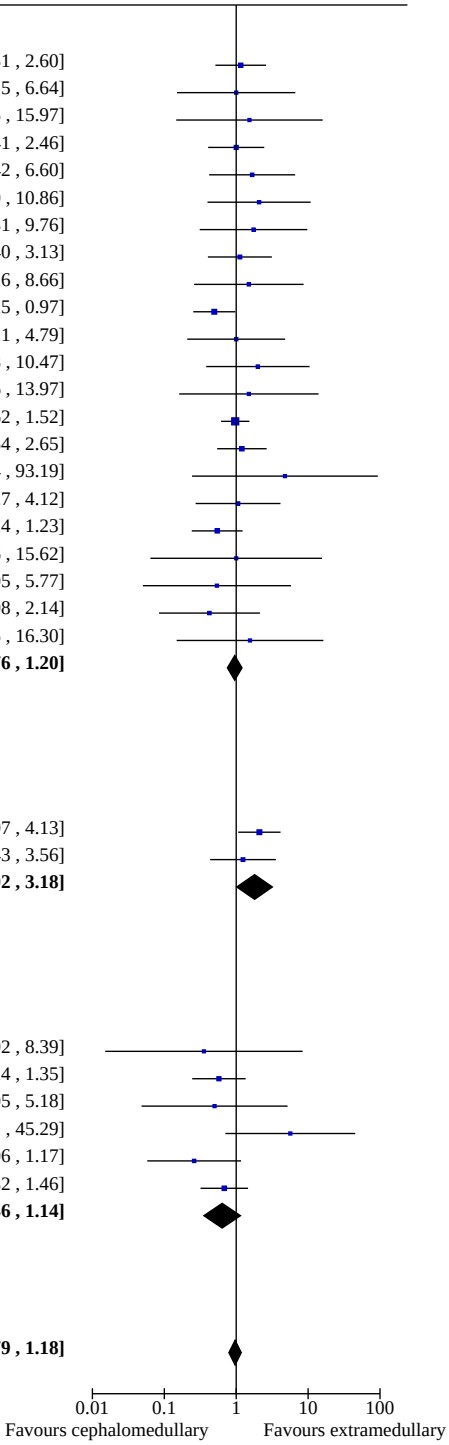


Footnotes

(1) We reversed data described as needing a walking aid in publication by Ahrengart 1994
(2) We reversed data reported as impaired walking
(3) Active with cane or no assistance
(4) Walking independently or with stick
(5) We reversed data reported as needing walking aids

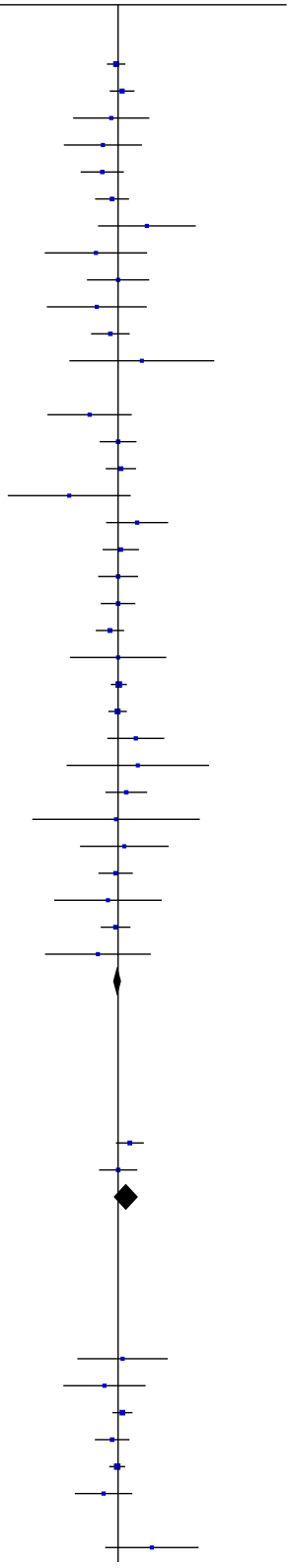
Analysis 2.4. Comparison 2: Cephalomedullary nails versus extramedullary implants: subgrouped by short or long intramedullary nails, Outcome 4: Early mortality

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
2.4.1 Short nail						
Bridle 1991	10	49	9	51	6.0%	1.16 [0.51 , 2.60]
Dujardin 2001	2	30	2	30	1.1%	1.00 [0.15 , 6.64]
Giraud 2005	2	34	1	26	0.7%	1.53 [0.15 , 15.97]
Guyer 1991	8	50	8	50	4.9%	1.00 [0.41 , 2.46]
Hardy 1998	5	50	3	50	2.1%	1.67 [0.42 , 6.60]
Harrington 2002	4	50	2	52	1.4%	2.08 [0.40 , 10.86]
Hoffman 1996	3	31	2	36	1.3%	1.74 [0.31 , 9.76]
Hoffmann 1999	7	56	6	54	3.7%	1.13 [0.40 , 3.13]
Kukla 1997	3	60	2	60	1.3%	1.50 [0.26 , 8.66]
Miedel 2005	11	109	22	108	8.6%	0.50 [0.25 , 0.97]
Ovesen 2006	3	73	3	73	1.6%	1.00 [0.21 , 4.79]
Pajarinen 2005	4	54	2	54	1.4%	2.00 [0.38 , 10.47]
Papasimos 2005	3	80	1	40	0.8%	1.50 [0.16 , 13.97]
Parker 2017	31	200	32	200	19.0%	0.97 [0.62 , 1.52]
Radford 1993	12	100	10	100	6.2%	1.20 [0.54 , 2.65]
Sadowski 2002	2	20	0	19	0.4%	4.76 [0.24 , 93.19]
Saudan 2002	4	100	4	106	2.1%	1.06 [0.27 , 4.12]
Utrilla 2005	8	104	15	106	5.9%	0.54 [0.24 , 1.23]
Verettas 2010	1	60	1	60	0.5%	1.00 [0.06 , 15.62]
Xu 2010	1	51	2	55	0.7%	0.54 [0.05 , 5.77]
Zehir 2015	2	96	5	102	1.5%	0.42 [0.08 , 2.14]
Zhou 2012	2	36	1	28	0.7%	1.56 [0.15 , 16.30]
Subtotal (95% CI)		**1493**		**1460**	**72.1%**	**0.95 [0.76 , 1.20]**
Total events:	128		133			
Heterogeneity: Tau² = 0.00; Chi² = 11.92, df = 21 (P = 0.94); I² = 0%						
Test for overall effect: Z = 0.40 (P = 0.69)						
2.4.2 Long nail						
Barton 2010	21	100	11	110	8.5%	2.10 [1.07 , 4.13]
Little 2008	7	92	6	98	3.5%	1.24 [0.43 , 3.56]
Subtotal (95% CI)		**192**		**208**	**12.1%**	**1.80 [1.02 , 3.18]**
Total events:	28		17			
Heterogeneity: Tau² = 0.00; Chi² = 0.67, df = 1 (P = 0.41); I² = 0%						
Test for overall effect: Z = 2.02 (P = 0.04)						
2.4.3 Mixed or unknown nail lengths						
Chechik 2014	0	29	1	31	0.4%	0.36 [0.02 , 8.39]
Matre 2013	8	341	14	343	5.3%	0.57 [0.24 , 1.35]
Michos 2001	1	26	2	26	0.7%	0.50 [0.05 , 5.18]
O'Brien 1995	6	52	1	49	0.9%	5.65 [0.71 , 45.29]
Pahlpatz 1993	2	51	8	53	1.7%	0.26 [0.06 , 1.17]
Sanders 2017	10	123	15	126	6.8%	0.68 [0.32 , 1.46]
Subtotal (95% CI)		**622**		**628**	**15.9%**	**0.64 [0.36 , 1.14]**
Total events:	27		41			
Heterogeneity: Tau² = 0.08; Chi² = 5.91, df = 5 (P = 0.32); I² = 15%						
Test for overall effect: Z = 1.51 (P = 0.13)						
Total (95% CI)		**2307**		**2296**	**100.0%**	**0.96 [0.79 , 1.18]**
Total events:	183		191			
Heterogeneity: Tau² = 0.00; Chi² = 25.82, df = 29 (P = 0.64); I² = 0%						
Test for overall effect: Z = 0.35 (P = 0.72)						
Test for subgroup differences: Chi² = 6.51, df = 2 (P = 0.04), I² = 69.3%						



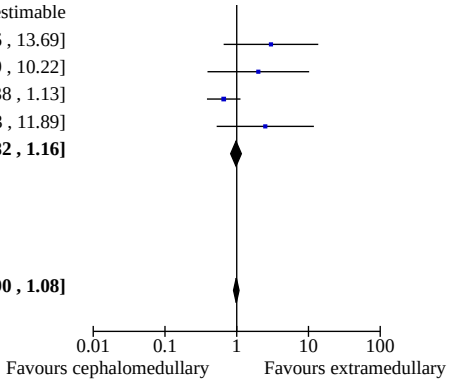
Analysis 2.5. Comparison 2: Cephalomedullary nails versus extramedullary implants: subgrouped by short or long intramedullary nails, Outcome 5: Mortality at 12 months

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
2.5.1 Short nail						
Adams 2001 (1)	59	203	61	197	8.5%	0.94 [0.70 , 1.27]
Ahrengart 1994 (2)	41	210	37	216	4.7%	1.14 [0.76 , 1.70]
Aktselis 2014 (1)	4	40	5	40	0.5%	0.80 [0.23 , 2.76]
Andalib 2020 (3)	3	43	8	70	0.5%	0.61 [0.17 , 2.18]
Baumgaertner 1998 (4)	10	65	17	66	1.6%	0.60 [0.30 , 1.21]
Bridle 1991 (5)	15	49	19	51	2.5%	0.82 [0.47 , 1.43]
Butt 1995 (6)	5	47	2	48	0.3%	2.55 [0.52 , 12.52]
Carulli 2017 (7)	2	71	4	69	0.3%	0.49 [0.09 , 2.57]
Dujardin 2001 (8)	6	30	6	30	0.7%	1.00 [0.36 , 2.75]
Eceviz 2020 (7)	2	32	4	32	0.3%	0.50 [0.10 , 2.54]
Ekstrom 2007 (9)	15	105	18	98	1.9%	0.78 [0.42 , 1.46]
Goldhagen 1994 (10)	2	36	1	39	0.1%	2.17 [0.21 , 22.89]
Gou 2013 (11)	0	45	0	45		Not estimable
Guerra 2014 (12)	2	12	8	19	0.4%	0.40 [0.10 , 1.56]
Hardy 1998 (4)	15	50	15	50	2.1%	1.00 [0.55 , 1.82]
Harrington 2002 (13)	20	50	19	52	3.1%	1.09 [0.67 , 1.79]
Haynes 1996 (10)	1	19	8	31	0.2%	0.20 [0.03 , 1.51]
Hoffman 1996 (10)	8	31	5	36	0.8%	1.86 [0.68 , 5.10]
Kouvidis 2012 (14)	19	86	16	79	2.2%	1.09 [0.60 , 1.97]
Kukla 1997 (10)	14	60	14	60	1.8%	1.00 [0.52 , 1.91]
Leung 1992 (10)	20	113	20	113	2.4%	1.00 [0.57 , 1.75]
Miedel 2005 (15)	24	109	31	108	3.6%	0.77 [0.48 , 1.22]
Ovesen 2006 (1)	3	73	3	73	0.3%	1.00 [0.21 , 4.79]
Parker 2012 (7)	83	300	81	300	11.2%	1.02 [0.79 , 1.33]
Parker 2017 (7)	59	200	60	200	8.4%	0.98 [0.73 , 1.33]
Reindl 2015 (16)	13	112	6	92	0.9%	1.78 [0.70 , 4.50]
Sadowski 2002 (17)	2	20	1	19	0.1%	1.90 [0.19 , 19.27]
Saudan 2002 (12)	16	100	13	106	1.7%	1.30 [0.66 , 2.57]
Sharma 2018 (18)	1	31	1	29	0.1%	0.94 [0.06 , 14.27]
Tao 2013 (7)	4	49	3	45	0.4%	1.22 [0.29 , 5.17]
Utrilla 2005 (1)	19	104	21	106	2.5%	0.92 [0.53 , 1.61]
Xu 2010 (19)	2	51	3	55	0.3%	0.72 [0.13 , 4.13]
Zehir 2015 (20)	23	93	26	97	3.3%	0.92 [0.57 , 1.50]
Zhou 2012 (21)	2	36	3	28	0.3%	0.52 [0.09 , 2.89]
Subtotal (95% CI)		**2675**		**2699**	**68.1%**	**0.97 [0.87 , 1.08]**
Total events:	514		539			
Heterogeneity: Tau² = 0.00; Chi² = 17.76, df = 32 (P = 0.98); I² = 0%						
Test for overall effect: Z = 0.60 (P = 0.55)						
2.5.2 Long nail						
Barton 2010 (22)	32	100	24	110	3.7%	1.47 [0.93 , 2.31]
Little 2008 (23)	16	92	17	98	2.0%	1.00 [0.54 , 1.86]
Subtotal (95% CI)		**192**		**208**	**5.7%**	**1.28 [0.89 , 1.85]**
Total events:	48		41			
Heterogeneity: Tau² = 0.00; Chi² = 0.94, df = 1 (P = 0.33); I² = 0%						
Test for overall effect: Z = 1.34 (P = 0.18)						
2.5.3 Mixed or unknown nail lengths						
Cai 2016	4	106	3	92	0.4%	1.16 [0.27 , 5.04]
Chechik 2014 (7)	3	29	5	31	0.4%	0.64 [0.17 , 2.45]
Davis 1988 (24)	48	116	41	114	7.2%	1.15 [0.83 , 1.60]
Lopez 2002 (1)	13	43	22	60	2.4%	0.82 [0.47 , 1.45]
Matre 2013 (25)	84	341	87	343	11.4%	0.97 [0.75 , 1.26]
Pahlpatz 1993 (10)	6	51	10	53	0.9%	0.62 [0.24 , 1.59]
Pelet 2001 (26)	0	13	0	13		Not estimable
Rahme 2007 (27)	6	30	2	30	0.3%	3.00 [0.66 , 13.69]



Analysis 2.5. (Continued)

Pelet 2001 (26)	0	13	0	13		Not estimable
Rahme 2007 (27)	6	30	2	30	0.3%	3.00 [0.66 , 13.69]
Raimondo 2012 (28)	4	35	2	35	0.3%	2.00 [0.39 , 10.22]
Sanders 2017 (7)	18	123	28	126	2.7%	0.66 [0.38 , 1.13]
Singh 2019 (29)	5	30	2	30	0.3%	2.50 [0.53 , 11.89]
Subtotal (95% CI)		**917**		**927**	**26.2%**	**0.98 [0.82 , 1.16]**
Total events:	191		202			
Heterogeneity: Tau² = 0.00; Chi² = 8.93, df = 9 (P = 0.44); I² = 0%						
Test for overall effect: Z = 0.26 (P = 0.79)						
Total (95% CI)		**3784**		**3834**	**100.0%**	**0.99 [0.90 , 1.08]**
Total events:	753		782			
Heterogeneity: Tau² = 0.00; Chi² = 29.75, df = 44 (P = 0.95); I² = 0%						
Test for overall effect: Z = 0.31 (P = 0.75)						
Test for subgroup differences: Chi² = 2.12, df = 2 (P = 0.35), I² = 5.7%						

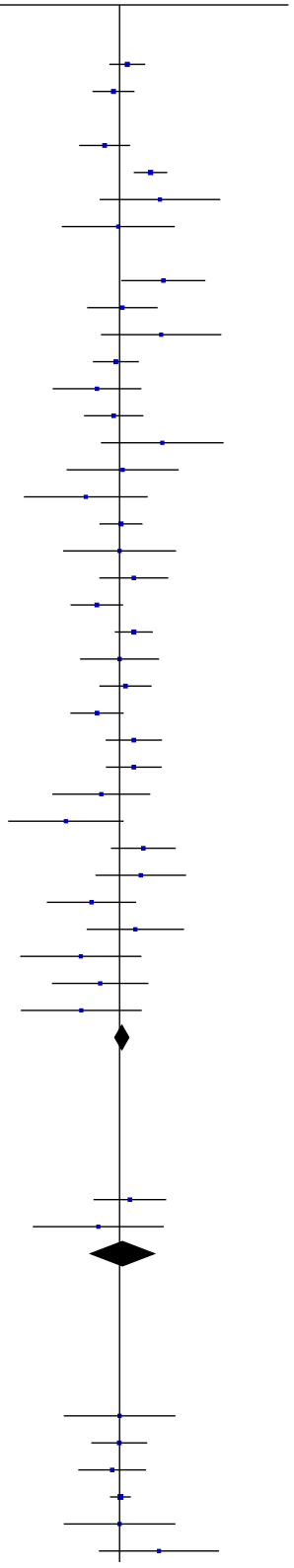


Footnotes

(1) Gamma nail vs SHS; at 12 months
(2) Gamma nail vs SHS; 6 months
(3) cephamedullary nail vs DHS and DCS; at 12 months
(4) IMHS vs SHS; at 12 months
(5) Gamma nail vs SHS (6 months)
(6) Gamma nail vs SHS (5 months)
(7) at 12 months
(8) Mini-invasive static (experimental) nail vs SHS; at 6 months
(9) PFN vs Medoff plate; at 12 months
(10) Gamma nail vs SHS; at 6 months
(11) 12 to 24 months
(12) PFN vs SHS; at 12 months
(13) IMHS vs SHS; at 6 months
(14) Endovis vs SHS; at 12 months
(15) Gamma nail vs Medoff plate; at 12 months
(16) Gamma, Trigen Intertan, TFN vs SHS; at 12 months
(17) PFN vs dynamic condylar plate (DCP); at 12 months
(18) at 24 months
(19) PFNA vs SHS; at 12 months
(20) at average of 16 months
(21) PFNA vs SHS; at 6 months
(22) Long gamma nail vs SHS; at 12 months
(23) Holland nail vs SHS; at 12 months
(24) Kuntscher-Y nail vs SHS; at 12 months
(25) Trigen Intertan nail vs SHS; at 12 months
(26) Gamma nail vs 90 degree blade plate; at 12 months
(27) PFN vs 95 degree blade plate; at 12 months
(28) ITST nail vs PCCP; at 12 months
(29) at 6 months

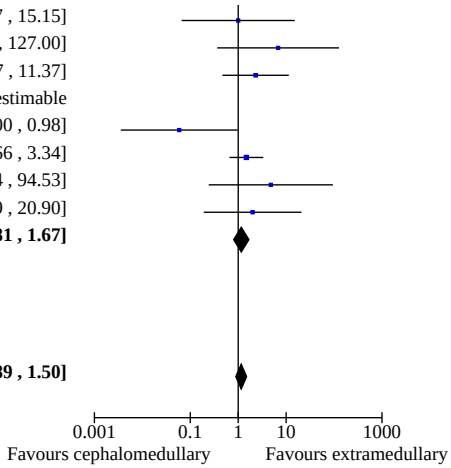
Analysis 2.6. Comparison 2: Cephalomedullary nails versus extramedullary implants: subgrouped by short or long intramedullary nails, Outcome 6: Unplanned return to theatre

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
2.6.1 Short nail						
Adams 2001 (1)	12	203	8	197	5.1%	1.46 [0.61 , 3.48]
Ahrengart 1994 (2)	6	105	8	104	4.2%	0.74 [0.27 , 2.07]
Aktselis 2014 (3)	0	40	0	40		Not estimable
Andalib 2020	3	38	9	55	3.2%	0.48 [0.14 , 1.67]
Benum 1994 (2)	29	429	7	467	5.5%	4.51 [2.00 , 10.19]
Butt 1995 (4)	3	47	0	48	0.7%	7.15 [0.38 , 134.67]
Carulli 2017 (5)	1	66	1	62	0.8%	0.94 [0.06 , 14.70]
Eceviz 2020 (6)	0	29	0	27		Not estimable
Ekstrom 2007 (7)	9	105	1	98	1.4%	8.40 [1.08 , 65.09]
Giraud 2005 (8)	3	34	2	26	1.9%	1.15 [0.21 , 6.37]
Goldhagen 1994 (9)	3	36	0	39	0.7%	7.57 [0.40 , 141.62]
Guyer 1991 (2)	5	50	6	50	3.7%	0.83 [0.27 , 2.55]
Haq 2014 (10)	1	17	3	17	1.3%	0.33 [0.04 , 2.89]
Hardy 1998 (11)	3	50	4	50	2.5%	0.75 [0.18 , 3.18]
Haynes 1996 (3)	2	19	0	31	0.7%	8.00 [0.40 , 158.22]
Hoffman 1996 (2)	1	31	1	36	0.8%	1.16 [0.08 , 17.80]
Hoffmann 1999 (12)	0	56	2	54	0.7%	0.19 [0.01 , 3.93]
Kouvidis 2012 (13)	7	86	6	79	4.1%	1.07 [0.38 , 3.05]
Kukla 1997 (2)	1	60	1	60	0.8%	1.00 [0.06 , 15.62]
Leung 1992 (3)	4	113	2	113	2.0%	2.00 [0.37 , 10.70]
Miedel 2005 (14)	3	109	9	108	3.1%	0.33 [0.09 , 1.19]
Ovesen 2006 (2)	12	73	6	73	4.8%	2.00 [0.79 , 5.04]
Pajarinen 2005 (15)	2	54	2	54	1.6%	1.00 [0.15 , 6.84]
Papasimos 2005 (16)	8	80	3	40	3.1%	1.33 [0.37 , 4.75]
Parker 2012 (5)	3	300	9	300	3.0%	0.33 [0.09 , 1.22]
Parker 2017	6	200	3	200	2.8%	2.00 [0.51 , 7.89]
Radford 1993 (2)	6	100	3	100	2.8%	2.00 [0.51 , 7.78]
Reindl 2015 (17)	1	112	2	92	1.1%	0.41 [0.04 , 4.46]
Sadowski 2002 (18)	0	20	6	19	0.8%	0.07 [0.00 , 1.22]
Saudan 2002 (15)	6	100	2	106	2.2%	3.18 [0.66 , 15.39]
Sharma 2018 (19)	3	31	1	29	1.2%	2.81 [0.31 , 25.48]
Utrilla 2005 (2)	1	104	4	106	1.3%	0.25 [0.03 , 2.24]
Xu 2010 (20)	2	51	1	55	1.1%	2.16 [0.20 , 23.07]
Zehir 2015	0	96	3	102	0.7%	0.15 [0.01 , 2.90]
Zhou 2012 (21)	1	36	2	28	1.1%	0.39 [0.04 , 4.07]
Zou 2009 (22)	0	58	3	63	0.7%	0.15 [0.01 , 2.94]
Subtotal (95% CI)		**3138**		**3128**	**71.7%**	**1.12 [0.79 , 1.57]**
Total events:	147		120			
Heterogeneity: Tau² = 0.29; Chi² = 48.63, df = 33 (P = 0.04); I² = 32%						
Test for overall effect: Z = 0.63 (P = 0.53)						
2.6.2 Long nail						
Barton 2010 (23)	3	100	2	110	1.8%	1.65 [0.28 , 9.67]
Little 2008 (24)	0	92	1	98	0.6%	0.35 [0.01 , 8.60]
Subtotal (95% CI)		**192**		**208**	**2.5%**	**1.15 [0.24 , 5.40]**
Total events:	3		3			
Heterogeneity: Tau² = 0.00; Chi² = 0.69, df = 1 (P = 0.41); I² = 0%						
Test for overall effect: Z = 0.18 (P = 0.86)						
2.6.3 Mixed and unknown nail lengths						
Chechik 2014	1	26	1	26	0.8%	1.00 [0.07 , 15.15]
Davis 1988 (25)	4	116	4	114	2.8%	0.98 [0.25 , 3.84]
Lopez 2002 (2)	2	43	4	60	2.0%	0.70 [0.13 , 3.64]
Matre 2013 (26)	28	341	27	343	8.3%	1.04 [0.63 , 1.73]
Michos 2001 (3)	1	26	1	26	0.8%	1.00 [0.07 , 15.15]
Mott 1993 (2)	3	35	0	34	0.7%	6.81 [0.36 , 127.00]



Analysis 2.6. (Continued)

Michos 2001 (3)	1	26	1	26	0.8%	1.00 [0.07 , 15.15]
Mott 1993 (2)	3	35	0	34	0.7%	6.81 [0.36 , 127.00]
O'Brien 1995 (2)	5	53	2	49	2.2%	2.31 [0.47 , 11.37]
Pelet 2001 (27)	0	13	0	13		Not estimable
Rahme 2007 (28)	0	30	8	30	0.8%	0.06 [0.00 , 0.98]
Sanders 2017 (6)	13	123	9	126	5.5%	1.48 [0.66 , 3.34]
Singh 2017	2	23	0	22	0.7%	4.79 [0.24 , 94.53]
Singh 2019 (5)	2	30	1	30	1.1%	2.00 [0.19 , 20.90]
Subtotal (95% CI)		**859**		**873**	**25.9%**	**1.16 [0.81 , 1.67]**
Total events:	61		57			
Heterogeneity: Tau² = 0.00; Chi² = 8.61, df = 10 (P = 0.57); I² = 0%						
Test for overall effect: Z = 0.80 (P = 0.43)						
Total (95% CI)		**4189**		**4209**	**100.0%**	**1.15 [0.89 , 1.50]**
Total events:	211		180			
Heterogeneity: Tau² = 0.14; Chi² = 57.85, df = 46 (P = 0.11); I² = 20%						
Test for overall effect: Z = 1.09 (P = 0.28)						
Test for subgroup differences: Chi² = 0.02, df = 2 (P = 0.99), I² = 0%						



Footnotes

(1) Gamma nail vs SHS; at 12 months
(2) Gamma nail vs SHS
(3) Gamma nail vs SHS
(4) Gamma nail vs SHS (5 months)
(5) 12 months
(6) at 12 months
(7) PFN vs Medoff plate
(8) Targon PF nail
(9) Gamma nail vs SHS; at 6 months
(10) PFN: failure for "technical reasons"; rDFLP: due to varus collapse; at 12 months
(11) IMHS vs SHS; at 12 months
(12) IMHS vs SHS
(13) Endovis nail vs SHS
(14) Gamma nail vs Medoff plate
(15) PFN vs SHS
(16) Gamma nail or PFN vs SHS
(17) Gamma nail, Trigen Intertan, TFN vs SHS
(18) PFN vs dynamic condylar plate (DCP)
(19) at 24 months
(20) PFNA vs SHS
(21) PFNA vs SHS at 26.8 months
(22) PFNA vs SHS; at 12 months
(23) Long gamma nail vs SHS (12 months)
(24) Holland nail vs SHS
(25) Kuntscher-Y nail vs SHS
(26) INTERTAN vs SHS; at 12 months
(27) Gamma nail vs 90 degree blade plate
(28) PFN vs 95 degree blade plate

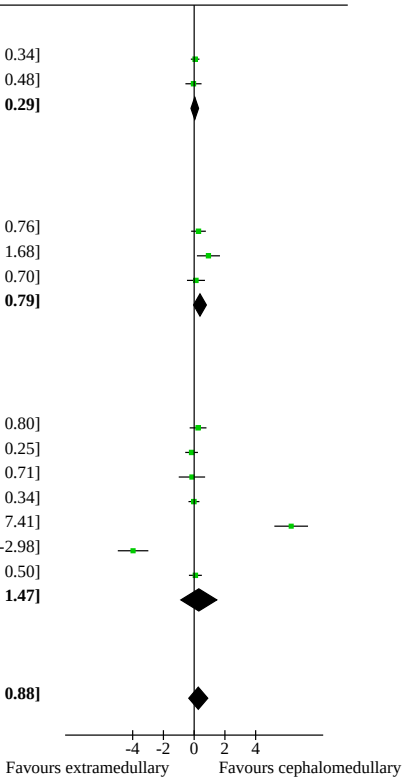
Comparison 3. Cephalomedullary nails versus extramedullary implants: subgrouped by stable and unstable fractures

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.1 Functional status at 12 months (mean scores)	12	899	Std. Mean Difference (IV, Random, 95% CI)	0.27 [-0.35, 0.88]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.1.1 Stable fractures	2	254	Std. Mean Difference (IV, Random, 95% CI)	0.04 [-0.21, 0.29]
3.1.2 Unstable fractures	3	144	Std. Mean Difference (IV, Random, 95% CI)	0.38 [-0.04, 0.79]
3.1.3 Mixed stable and unstable	7	501	Std. Mean Difference (IV, Random, 95% CI)	0.30 [-0.87, 1.47]
3.2 Mobility at 12 months (mobility scales, mean scores)	14	1746	Mean Difference (IV, Random, 95% CI)	0.48 [0.10, 0.87]
3.2.1 Unstable fractures	5	265	Mean Difference (IV, Random, 95% CI)	0.73 [0.19, 1.26]
3.2.2 Mixed stable and unstable fractures	9	1481	Mean Difference (IV, Random, 95% CI)	0.42 [-0.06, 0.90]
3.3 Mobility (12 months; independent mobility)	12	1524	Risk Ratio (M-H, Random, 95% CI)	1.07 [0.94, 1.22]
3.3.1 Unstable fractures	2	318	Risk Ratio (M-H, Random, 95% CI)	1.34 [0.64, 2.82]
3.3.2 Mixed stable and unstable fractures	10	1206	Risk Ratio (M-H, Random, 95% CI)	1.02 [0.92, 1.14]
3.4 Early mortality	30	4603	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.79, 1.18]
3.4.1 Unstable fractures	8	1112	Risk Ratio (M-H, Random, 95% CI)	1.05 [0.54, 2.07]
3.4.2 Mixed stable and unstable fractures	22	3491	Risk Ratio (M-H, Random, 95% CI)	0.95 [0.76, 1.19]
3.5 Mortality at 12 months	46	7558	Risk Ratio (M-H, Random, 95% CI)	0.98 [0.90, 1.07]
3.5.1 Stable fractures	3	322	Risk Ratio (M-H, Random, 95% CI)	0.81 [0.29, 2.23]
3.5.2 Unstable fractures	10	1464	Risk Ratio (M-H, Random, 95% CI)	1.01 [0.82, 1.24]
3.5.3 Mixed stable and unstable fractures	33	5772	Risk Ratio (M-H, Random, 95% CI)	0.98 [0.89, 1.08]
3.6 Unplanned return to theatre	49	8338	Risk Ratio (M-H, Random, 95% CI)	1.19 [0.93, 1.53]
3.6.1 Stable fractures	2	116	Risk Ratio (M-H, Random, 95% CI)	2.81 [0.31, 25.48]
3.6.2 Unstable fractures	12	1549	Risk Ratio (M-H, Random, 95% CI)	0.78 [0.38, 1.61]
3.6.3 Mixed stable and unstable fractures	35	6673	Risk Ratio (M-H, Random, 95% CI)	1.30 [1.03, 1.65]

Analysis 3.1. Comparison 3: Cephalomedullary nails versus extramedullary implants: subgrouped by stable and unstable fractures, Outcome 1: Functional status at 12 months (mean scores)

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
3.1.1 Stable fractures								
Cai 2016 (1)	36.1	2.38	106	35.96	1.99	92	9.0%	0.06 [-0.22 , 0.34]
Eceviz 2020 (2)	70.38	10.1	29	70.81	8.99	27	8.6%	-0.04 [-0.57 , 0.48]
Subtotal (95% CI)			**135**			**119**	**17.6%**	**0.04 [-0.21 , 0.29]**
Heterogeneity: Tau² = 0.00; Chi² = 0.13, df = 1 (P = 0.72); I² = 0%								
Test for overall effect: Z = 0.31 (P = 0.75)								
3.1.2 Unstable fractures								
Adeel 2020 (2)	87.62	17.28	34	81.83	23.01	34	8.7%	0.28 [-0.20 , 0.76]
Haq 2014 (2)	81.53	13.21	17	68.43	14.36	14	8.1%	0.93 [0.18 , 1.68]
Singh 2017 (2)	82.8	10.5	23	81	18.8	22	8.5%	0.12 [-0.47 , 0.70]
Subtotal (95% CI)			**74**			**70**	**25.2%**	**0.38 [-0.04 , 0.79]**
Heterogeneity: Tau² = 0.04; Chi² = 2.98, df = 2 (P = 0.23); I² = 33%								
Test for overall effect: Z = 1.79 (P = 0.07)								
3.1.3 Mixed stable and unstable								
Chechik 2014 (2)	67	15	26	63	16	26	8.5%	0.25 [-0.29 , 0.80]
Gou 2013 (3)	22.8	7	45	24	7.2	45	8.8%	-0.17 [-0.58 , 0.25]
Guerra 2014 (4)	33.8	7.11	10	35.09	9.61	11	7.8%	-0.15 [-1.00 , 0.71]
Kouvidis 2012 (5)	74.33	25.19	62	74.66	21.21	60	8.9%	-0.01 [-0.37 , 0.34]
Li 2018 (2)	85.3	2.4	40	72.3	1.6	40	7.1%	6.31 [5.22 , 7.41]
Singh 2019 (6)	79.73	1.2	24	85.46	1.6	25	7.4%	-3.97 [-4.97 , -2.98]
Tao 2013 (7)	82.8	9.5	45	82	10.4	42	8.8%	0.08 [-0.34 , 0.50]
Subtotal (95% CI)			**252**			**249**	**57.2%**	**0.30 [-0.87 , 1.47]**
Heterogeneity: Tau² = 2.35; Chi² = 190.70, df = 6 (P < 0.00001); I² = 97%								
Test for overall effect: Z = 0.51 (P = 0.61)								
Total (95% CI)			**461**			**438**	**100.0%**	**0.27 [-0.35 , 0.88]**
Heterogeneity: Tau² = 1.08; Chi² = 196.58, df = 11 (P < 0.00001); I² = 94%								
Test for overall effect: Z = 0.85 (P = 0.40)								
Test for subgroup differences: Chi² = 1.97, df = 2 (P = 0.37), I² = 0%								

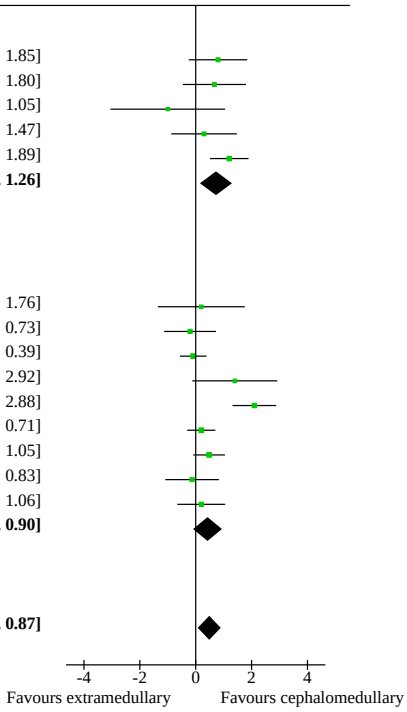


Footnotes

(1) Zűckerman (0 to 44; higher scores indicate better function)
(2) HHS (higher scores indicate better function)
(3) OHS (range 0 to 48, higher scores indicate better function)
(4) Zuckerman (0 to 44; higher scores indicate better function)
(5) Functional recovery score (0 to 100; higher scores indicate better function)
(6) Modified HHS (higher scores indicate better function)
(7) Modified HHS;

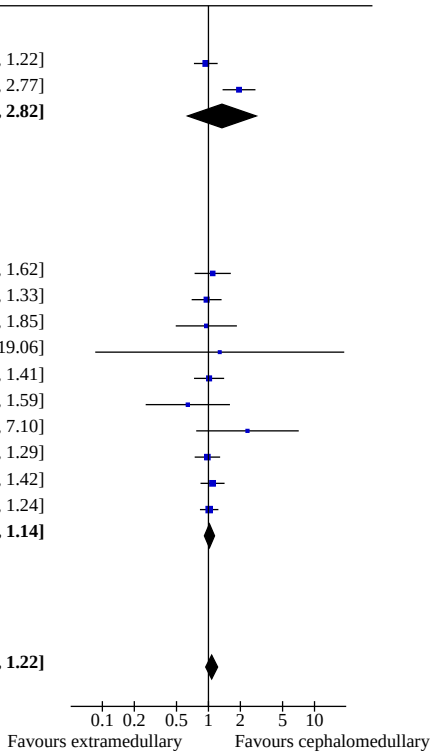
Analysis 3.2. Comparison 3: Cephalomedullary nails versus extramedullary implants: subgrouped by stable and unstable fractures, Outcome 2: Mobility at 12 months (mobility scales, mean scores)

Study or Subgroup	Cephalomedullary Mean	SD	Total	Extramedullary Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.2.1 Unstable fractures								
Aktselis 2014	6.5	2.3	36	5.7	2.2	35	6.5%	0.80 [-0.25 , 1.85]
Haq 2014	7.53	1.807	17	6.86	1.4	14	6.0%	0.67 [-0.46 , 1.80]
Sadowski 2002	5	2.6	18	6	3.5	17	2.7%	-1.00 [-3.05 , 1.05]
Singh 2017	6.3	2.1	23	6	1.92	22	5.8%	0.30 [-0.87 , 1.47]
Xu 2010	5.6	1.4	40	4.4	1.8	43	9.0%	1.20 [0.51 , 1.89]
Subtotal (95% CI)			**134**			**131**	**30.1%**	**0.73 [0.19 , 1.26]**
Heterogeneity: Tau² = 0.08; Chi² = 4.99, df = 4 (P = 0.29); I² = 20%								
Test for overall effect: Z = 2.65 (P = 0.008)								
3.2.2 Mixed stable and unstable fractures								
Chechik 2014	4.3	3.1	26	4.1	2.6	26	4.1%	0.20 [-1.36 , 1.76]
Gou 2013	6.7	2.8	45	6.9	1.5	45	7.3%	-0.20 [-1.13 , 0.73]
Han 2012	7.59	1.12	41	7.68	1.09	42	10.7%	-0.09 [-0.57 , 0.39]
Hardy 1998	4.8	3.2	35	3.4	3.3	35	4.2%	1.40 [-0.12 , 2.92]
Little 2008	5.9	2.67	76	3.8	2.28	80	8.3%	2.10 [1.32 , 2.88]
Parker 2012	4.84	2.7	209	4.64	2.6	213	10.5%	0.20 [-0.31 , 0.71]
Parker 2017	5.95	2.5	139	5.47	2.3	138	10.0%	0.48 [-0.09 , 1.05]
Saudan 2002	4.94	3.33	79	5.07	2.97	89	7.1%	-0.13 [-1.09 , 0.83]
Utrilla 2005	6.4	2.8	82	6.2	2.79	81	7.8%	0.20 [-0.66 , 1.06]
Subtotal (95% CI)			**732**			**749**	**69.9%**	**0.42 [-0.06 , 0.90]**
Heterogeneity: Tau² = 0.35; Chi² = 27.40, df = 8 (P = 0.0006); I² = 71%								
Test for overall effect: Z = 1.72 (P = 0.09)								
Total (95% CI)			**866**			**880**	**100.0%**	**0.48 [0.10 , 0.87]**
Heterogeneity: Tau² = 0.30; Chi² = 35.31, df = 13 (P = 0.0008); I² = 63%								
Test for overall effect: Z = 2.49 (P = 0.01)								
Test for subgroup differences: Chi² = 0.68, df = 1 (P = 0.41), I² = 0%								



Analysis 3.3. Comparison 3: Cephalomedullary nails versus extramedullary implants: subgrouped by stable and unstable fractures, Outcome 3: Mobility (12 months; independent mobility)

Study or Subgroup	Cephalomedullary Events	Total	Extramedullary Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
3.3.1 Unstable fractures						
Ekstrom 2007	41	64	38	56	13.4%	0.94 [0.73 , 1.22]
Zehir 2015	53	96	29	102	9.0%	1.94 [1.36 , 2.77]
Subtotal (95% CI)		**160**		**158**	**22.4%**	**1.34 [0.64 , 2.82]**
Total events:	94		67			
Heterogeneity: Tau² = 0.26; Chi² = 11.46, df = 1 (P = 0.0007); I² = 91%						
Test for overall effect: Z = 0.77 (P = 0.44)						
3.3.2 Mixed stable and unstable fractures						
Leung 1992	34	93	31	93	7.9%	1.10 [0.74 , 1.62]
Ahrengart 1994 (1)	49	169	54	179	10.2%	0.96 [0.69 , 1.33]
Goldhagen 1994	10	29	13	36	3.4%	0.95 [0.49 , 1.85]
Haynes 1996	1	18	1	23	0.2%	1.28 [0.09 , 19.06]
Kukla 1997 (2)	28	45	27	44	10.1%	1.01 [0.73 , 1.41]
Kuwabara 1998 (3)	5	20	9	23	1.9%	0.64 [0.26 , 1.59]
Pelet 2001 (4)	7	13	3	13	1.3%	2.33 [0.77 , 7.10]
Adams 2001	56	126	55	121	12.4%	0.98 [0.74 , 1.29]
Varela-Egocheaga 2009 (5)	30	38	26	36	13.2%	1.09 [0.84 , 1.42]
Tao 2013	37	45	34	42	17.0%	1.02 [0.83 , 1.24]
Subtotal (95% CI)		**596**		**610**	**77.6%**	**1.02 [0.92 , 1.14]**
Total events:	257		253			
Heterogeneity: Tau² = 0.00; Chi² = 3.83, df = 9 (P = 0.92); I² = 0%						
Test for overall effect: Z = 0.40 (P = 0.69)						
Total (95% CI)		**756**		**768**	**100.0%**	**1.07 [0.94 , 1.22]**
Total events:	351		320			
Heterogeneity: Tau² = 0.02; Chi² = 16.33, df = 11 (P = 0.13); I² = 33%						
Test for overall effect: Z = 1.06 (P = 0.29)						
Test for subgroup differences: Chi² = 0.50, df = 1 (P = 0.48), I² = 0%						

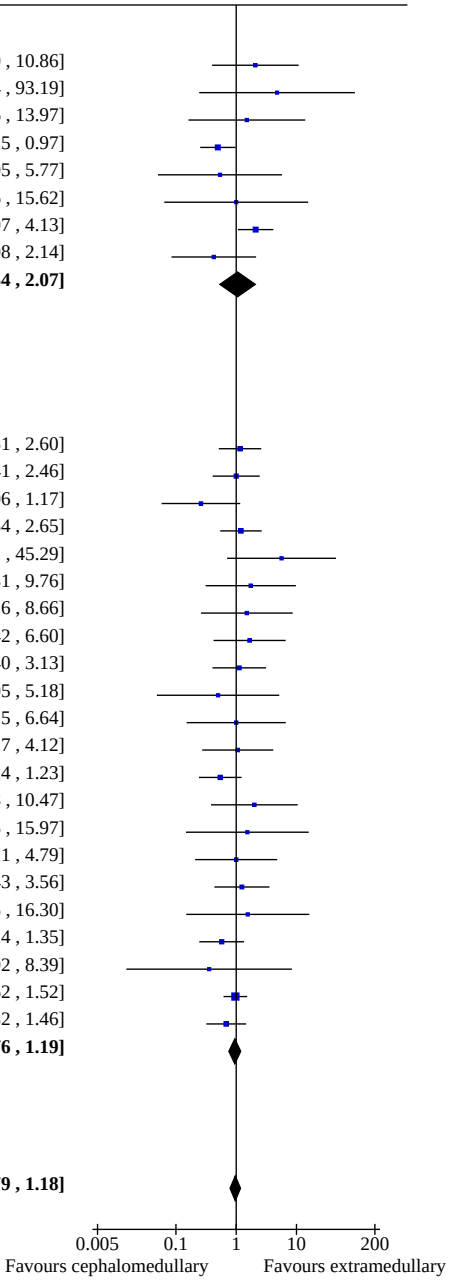


Footnotes

(1) We reversed data described as needing a walking aid in publication by Ahrengart 1994
(2) We reversed data reported as impaired walking
(3) Walking independently or with stick
(4) We reversed data reported as needing walking aids
(5) Active with cane or no assistance

Analysis 3.4. Comparison 3: Cephalomedullary nails versus extramedullary implants: subgrouped by stable and unstable fractures, Outcome 4: Early mortality

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
3.4.1 Unstable fractures						
Harrington 2002	4	50	2	52	1.4%	2.08 [0.40 , 10.86]
Sadowski 2002	2	20	0	19	0.4%	4.76 [0.24 , 93.19]
Papasimos 2005	3	80	1	40	0.8%	1.50 [0.16 , 13.97]
Miedel 2005	11	109	22	108	8.6%	0.50 [0.25 , 0.97]
Xu 2010	1	51	2	55	0.7%	0.54 [0.05 , 5.77]
Verettas 2010	1	60	1	60	0.5%	1.00 [0.06 , 15.62]
Barton 2010	21	100	11	110	8.5%	2.10 [1.07 , 4.13]
Zehir 2015	2	96	5	102	1.5%	0.42 [0.08 , 2.14]
Subtotal (95% CI)		**566**		**546**	**22.6%**	**1.05 [0.54 , 2.07]**
Total events:	45		44			
Heterogeneity: Tau² = 0.33; Chi² = 12.05, df = 7 (P = 0.10); I² = 42%						
Test for overall effect: Z = 0.15 (P = 0.88)						
3.4.2 Mixed stable and unstable fractures						
Bridle 1991	10	49	9	51	6.0%	1.16 [0.51 , 2.60]
Guyer 1991	8	50	8	50	4.9%	1.00 [0.41 , 2.46]
Pahlpatz 1993	2	51	8	53	1.7%	0.26 [0.06 , 1.17]
Radford 1993	12	100	10	100	6.2%	1.20 [0.54 , 2.65]
O'Brien 1995	6	52	1	49	0.9%	5.65 [0.71 , 45.29]
Hoffman 1996	3	31	2	36	1.3%	1.74 [0.31 , 9.76]
Kukla 1997	3	60	2	60	1.3%	1.50 [0.26 , 8.66]
Hardy 1998	5	50	3	50	2.1%	1.67 [0.42 , 6.60]
Hoffmann 1999	7	56	6	54	3.7%	1.13 [0.40 , 3.13]
Michos 2001	1	26	2	26	0.7%	0.50 [0.05 , 5.18]
Dujardin 2001	2	30	2	30	1.1%	1.00 [0.15 , 6.64]
Saudan 2002	4	100	4	106	2.1%	1.06 [0.27 , 4.12]
Utrilla 2005	8	104	15	106	5.9%	0.54 [0.24 , 1.23]
Pajarinen 2005	4	54	2	54	1.4%	2.00 [0.38 , 10.47]
Giraud 2005	2	34	1	26	0.7%	1.53 [0.15 , 15.97]
Ovesen 2006	3	73	3	73	1.6%	1.00 [0.21 , 4.79]
Little 2008	7	92	6	98	3.5%	1.24 [0.43 , 3.56]
Zhou 2012	2	36	1	28	0.7%	1.56 [0.15 , 16.30]
Matre 2013	8	341	14	343	5.3%	0.57 [0.24 , 1.35]
Chechik 2014	0	29	1	31	0.4%	0.36 [0.02 , 8.39]
Parker 2017	31	200	32	200	19.0%	0.97 [0.62 , 1.52]
Sanders 2017	10	123	15	126	6.8%	0.68 [0.32 , 1.46]
Subtotal (95% CI)		**1741**		**1750**	**77.4%**	**0.95 [0.76 , 1.19]**
Total events:	138		147			
Heterogeneity: Tau² = 0.00; Chi² = 13.65, df = 21 (P = 0.88); I² = 0%						
Test for overall effect: Z = 0.47 (P = 0.64)						
Total (95% CI)		**2307**		**2296**	**100.0%**	**0.96 [0.79 , 1.18]**
Total events:	183		191			
Heterogeneity: Tau² = 0.00; Chi² = 25.82, df = 29 (P = 0.64); I² = 0%						
Test for overall effect: Z = 0.35 (P = 0.72)						
Test for subgroup differences: Chi² = 0.08, df = 1 (P = 0.77), I² = 0%						

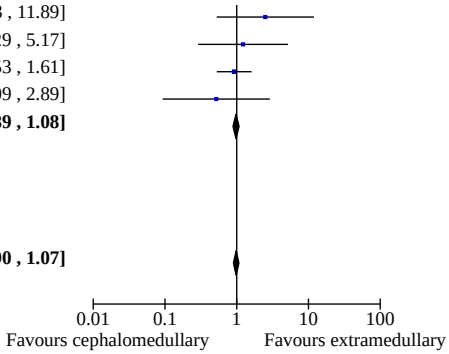


Analysis 3.5. Comparison 3: Cephalomedullary nails versus extramedullary implants: subgrouped by stable and unstable fractures, Outcome 5: Mortality at 12 months

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
3.5.1 Stable fractures						
Cai 2016	4	106	3	92	0.4%	1.16 [0.27 , 5.04]
Eceviz 2020	2	32	4	32	0.3%	0.50 [0.10 , 2.54]
Sharma 2018	1	31	1	29	0.1%	0.94 [0.06 , 14.27]
Subtotal (95% CI)		**169**		**153**	**0.7%**	**0.81 [0.29 , 2.23]**
Total events:	7		8			
Heterogeneity: Tau² = 0.00; Chi² = 0.58, df = 2 (P = 0.75); I² = 0%						
Test for overall effect: Z = 0.40 (P = 0.69)						
3.5.2 Unstable fractures						
Aktselis 2014	4	40	5	40	0.5%	0.80 [0.23 , 2.76]
Andalib 2020	3	43	8	70	0.5%	0.61 [0.17 , 2.18]
Barton 2010	32	100	24	110	3.7%	1.47 [0.93 , 2.31]
Ekstrom 2007	15	105	18	98	2.0%	0.78 [0.42 , 1.46]
Harrington 2002	20	50	19	52	3.2%	1.09 [0.67 , 1.79]
Miedel 2005	24	109	31	108	3.6%	0.77 [0.48 , 1.22]
Reindl 2015	13	112	6	92	0.9%	1.78 [0.70 , 4.50]
Sadowski 2002	2	20	1	19	0.1%	1.90 [0.19 , 19.27]
Xu 2010	2	51	3	55	0.3%	0.72 [0.13 , 4.13]
Zehir 2015	23	93	26	97	3.3%	0.92 [0.57 , 1.50]
Subtotal (95% CI)		**723**		**741**	**18.0%**	**1.01 [0.82 , 1.24]**
Total events:	138		141			
Heterogeneity: Tau² = 0.00; Chi² = 7.46, df = 9 (P = 0.59); I² = 0%						
Test for overall effect: Z = 0.09 (P = 0.93)						
3.5.3 Mixed stable and unstable fractures						
Adams 2001	59	203	61	197	8.6%	0.94 [0.70 , 1.27]
Ahrengart 1994	41	210	37	216	4.8%	1.14 [0.76 , 1.70]
Baumgaertner 1998	10	65	17	66	1.6%	0.60 [0.30 , 1.21]
Bridle 1991	15	49	19	51	2.5%	0.82 [0.47 , 1.43]
Butt 1995	5	47	2	48	0.3%	2.55 [0.52 , 12.52]
Carulli 2017	2	71	4	69	0.3%	0.49 [0.09 , 2.57]
Chechik 2014	3	29	5	31	0.4%	0.64 [0.17 , 2.45]
Davis 1988	48	116	41	114	7.2%	1.15 [0.83 , 1.60]
Dujardin 2001	6	30	6	30	0.8%	1.00 [0.36 , 2.75]
Goldhagen 1994	2	36	1	39	0.1%	2.17 [0.21 , 22.89]
Gou 2013	0	45	0	45		Not estimable
Guerra 2014	2	12	8	19	0.4%	0.40 [0.10 , 1.56]
Hardy 1998	15	50	15	50	2.1%	1.00 [0.55 , 1.82]
Haynes 1996	1	19	8	31	0.2%	0.20 [0.03 , 1.51]
Hoffman 1996	8	31	5	36	0.8%	1.86 [0.68 , 5.10]
Kouvidis 2012	19	86	16	79	2.2%	1.09 [0.60 , 1.97]
Kukla 1997	14	60	14	60	1.8%	1.00 [0.52 , 1.91]
Leung 1992	20	113	20	113	2.4%	1.00 [0.57 , 1.75]
Little 2008	16	92	17	98	2.0%	1.00 [0.54 , 1.86]
Lopez 2002	13	43	22	60	2.4%	0.82 [0.47 , 1.45]
Matre 2013	84	341	87	343	11.4%	0.97 [0.75 , 1.26]
Ovesen 2006	3	73	3	73	0.3%	1.00 [0.21 , 4.79]
Pahlpatz 1993	6	51	10	53	0.9%	0.62 [0.24 , 1.59]
Parker 2012	83	300	81	300	11.3%	1.02 [0.79 , 1.33]
Parker 2017	59	200	60	200	8.5%	0.98 [0.73 , 1.33]
Pelet 2001	0	13	0	13		Not estimable
Raimondo 2012	4	35	2	35	0.3%	2.00 [0.39 , 10.22]
Sanders 2017	18	123	28	126	2.7%	0.66 [0.38 , 1.13]
Saudan 2002	16	100	13	106	1.7%	1.30 [0.66 , 2.57]
Singh 2019	5	30	2	30	0.3%	2.50 [0.53 , 11.89]
Tao 2013	4	49	3	45	0.4%	1.22 [0.29 , 5.17]

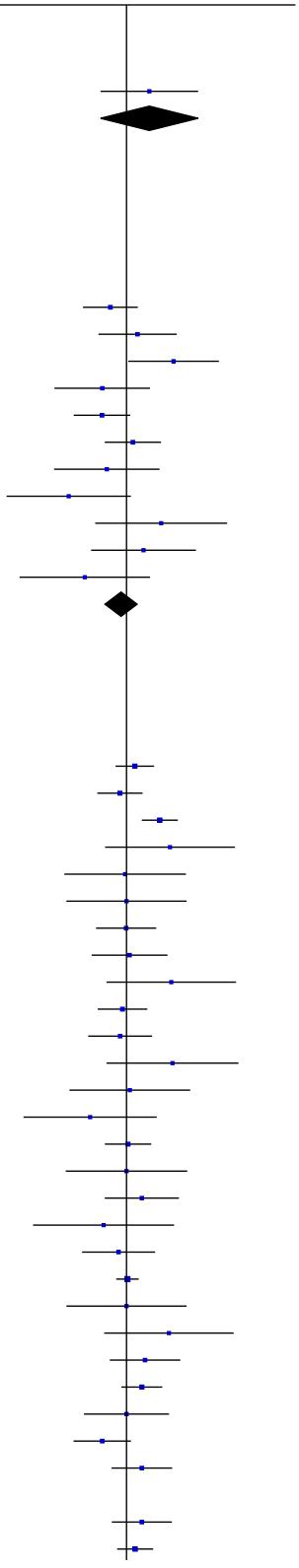
Analysis 3.5. (Continued)

Singh 2019	5	30	2	30	0.3%	2.50 [0.53 , 11.89]
Tao 2013	4	49	3	45	0.4%	1.22 [0.29 , 5.17]
Utrilla 2005	19	104	21	106	2.5%	0.92 [0.53 , 1.61]
Zhou 2012	2	36	3	28	0.3%	0.52 [0.09 , 2.89]
Subtotal (95% CI)		**2862**		**2910**	**81.3%**	**0.98 [0.89 , 1.08]**
Total events:	602		631			
Heterogeneity: Tau² = 0.00; Chi² = 19.44, df = 30 (P = 0.93); I² = 0%						
Test for overall effect: Z = 0.44 (P = 0.66)						
Total (95% CI)		**3754**		**3804**	**100.0%**	**0.98 [0.90 , 1.07]**
Total events:	747		780			
Heterogeneity: Tau² = 0.00; Chi² = 27.68, df = 43 (P = 0.97); I² = 0%						
Test for overall effect: Z = 0.40 (P = 0.69)						
Test for subgroup differences: Chi² = 0.21, df = 2 (P = 0.90), I² = 0%						



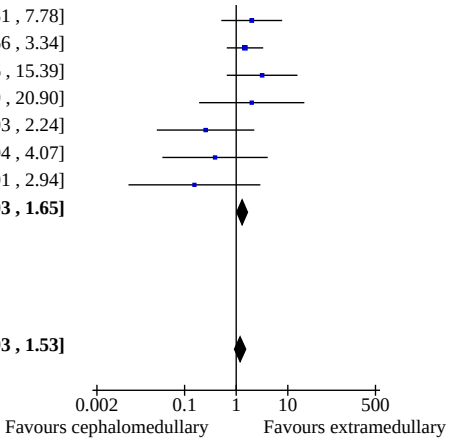
Analysis 3.6. Comparison 3: Cephalomedullary nails versus extramedullary implants: subgrouped by stable and unstable fractures, Outcome 6: Unplanned return to theatre

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
3.6.1 Stable fractures						
Eceviz 2020	0	29	0	27		Not estimable
Sharma 2018	3	31	1	29	1.2%	2.81 [0.31 , 25.48]
Subtotal (95% CI)		**60**		**56**	**1.2%**	**2.81 [0.31 , 25.48]**
Total events:	3		1			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.92 (P = 0.36)						
3.6.2 Unstable fractures						
Aktselis 2014	0	40	0	40		Not estimable
Andalib 2020	3	38	9	55	3.2%	0.48 [0.14 , 1.67]
Barton 2010	3	100	2	110	1.8%	1.65 [0.28 , 9.67]
Ekstrom 2007	9	105	1	98	1.4%	8.40 [1.08 , 65.09]
Haq 2014	1	17	3	17	1.2%	0.33 [0.04 , 2.89]
Miedel 2005	3	109	9	108	3.1%	0.33 [0.09 , 1.19]
Papasimos 2005	8	80	3	40	3.1%	1.33 [0.37 , 4.75]
Reindl 2015	1	112	2	92	1.0%	0.41 [0.04 , 4.46]
Sadowski 2002	0	20	6	19	0.7%	0.07 [0.00 , 1.22]
Singh 2017	2	23	0	22	0.7%	4.79 [0.24 , 94.53]
Xu 2010	2	51	1	55	1.0%	2.16 [0.20 , 23.07]
Zehir 2015	0	96	3	102	0.7%	0.15 [0.01 , 2.90]
Subtotal (95% CI)		**791**		**758**	**17.8%**	**0.78 [0.38 , 1.61]**
Total events:	32		39			
Heterogeneity: Tau² = 0.51; Chi² = 15.76, df = 10 (P = 0.11); I² = 37%						
Test for overall effect: Z = 0.67 (P = 0.51)						
3.6.3 Mixed stable and unstable fractures						
Adams 2001	12	203	8	197	5.4%	1.46 [0.61 , 3.48]
Ahrengart 1994	6	105	8	104	4.3%	0.74 [0.27 , 2.07]
Benum 1994	29	429	7	467	5.9%	4.51 [2.00 , 10.19]
Butt 1995	3	47	0	48	0.7%	7.15 [0.38 , 134.67]
Carulli 2017	1	66	1	62	0.8%	0.94 [0.06 , 14.70]
Chechik 2014	1	26	1	26	0.8%	1.00 [0.07 , 15.15]
Davis 1988	4	116	4	114	2.8%	0.98 [0.25 , 3.84]
Giraud 2005	3	34	2	26	1.9%	1.15 [0.21 , 6.37]
Goldhagen 1994	3	36	0	39	0.7%	7.57 [0.40 , 141.62]
Guyer 1991	5	50	6	50	3.8%	0.83 [0.27 , 2.55]
Hardy 1998	3	50	4	50	2.5%	0.75 [0.18 , 3.18]
Haynes 1996	2	19	0	31	0.7%	8.00 [0.40 , 158.22]
Hoffman 1996	1	31	1	36	0.8%	1.16 [0.08 , 17.80]
Hoffmann 1999	0	56	2	54	0.7%	0.19 [0.01 , 3.93]
Kouvidis 2012	7	86	6	79	4.2%	1.07 [0.38 , 3.05]
Kukla 1997	1	60	1	60	0.8%	1.00 [0.06 , 15.62]
Leung 1992	4	113	2	113	1.9%	2.00 [0.37 , 10.70]
Little 2008	0	92	1	98	0.6%	0.35 [0.01 , 8.60]
Lopez 2002	2	43	4	60	2.0%	0.70 [0.13 , 3.64]
Matre 2013	28	341	27	343	9.5%	1.04 [0.63 , 1.73]
Michos 2001	1	26	1	26	0.8%	1.00 [0.07 , 15.15]
Mott 1993	3	35	0	34	0.7%	6.81 [0.36 , 127.00]
O'Brien 1995	5	53	2	49	2.1%	2.31 [0.47 , 11.37]
Ovesen 2006	12	73	6	73	5.0%	2.00 [0.79 , 5.04]
Pajarinen 2005	2	54	2	54	1.5%	1.00 [0.15 , 6.84]
Parker 2012	3	300	9	300	3.0%	0.33 [0.09 , 1.22]
Parker 2017	6	200	3	200	2.7%	2.00 [0.51 , 7.89]
Pelet 2001	0	13	0	13		Not estimable
Radford 1993	6	100	3	100	2.8%	2.00 [0.51 , 7.78]
Sanders 2017	13	123	9	126	5.9%	1.48 [0.66 , 3.34]



Analysis 3.6. (Continued)

Radford 1993	6	100	3	100	2.8%	2.00 [0.51 , 7.78]
Sanders 2017	13	123	9	126	5.9%	1.48 [0.66 , 3.34]
Saudan 2002	6	100	2	106	2.2%	3.18 [0.66 , 15.39]
Singh 2019	2	30	1	30	1.1%	2.00 [0.19 , 20.90]
Utrilla 2005	1	104	4	106	1.2%	0.25 [0.03 , 2.24]
Zhou 2012	1	36	2	28	1.0%	0.39 [0.04 , 4.07]
Zou 2009	0	58	3	63	0.7%	0.15 [0.01 , 2.94]
Subtotal (95% CI)		**3308**		**3365**	**81.0%**	**1.30 [1.03 , 1.65]**
Total events:	176		132			
Heterogeneity: Tau² = 0.01; Chi² = 33.96, df = 33 (P = 0.42); I² = 3%						
Test for overall effect: Z = 2.17 (P = 0.03)						
Total (95% CI)		**4159**		**4179**	**100.0%**	**1.19 [0.93 , 1.53]**
Total events:	211		172			
Heterogeneity: Tau² = 0.10; Chi² = 53.41, df = 45 (P = 0.18); I² = 16%						
Test for overall effect: Z = 1.36 (P = 0.17)						
Test for subgroup differences: Chi² = 2.24, df = 2 (P = 0.33), I² = 10.6%						

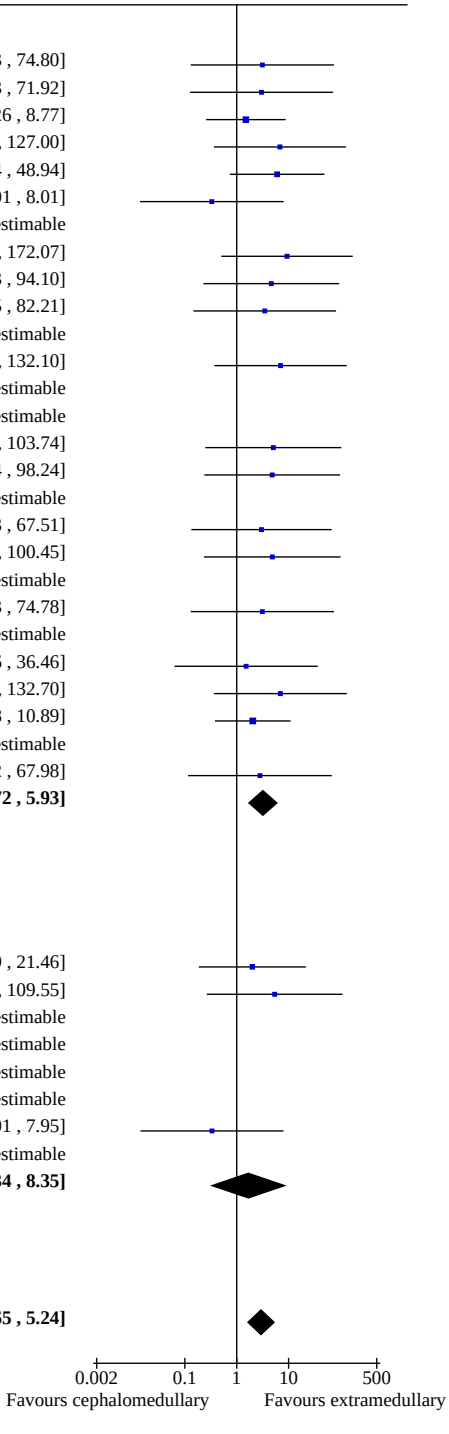


Comparison 4. Intraoperative and postoperative periprosthetic fractures: subgrouped by year of publication

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.1 Intraoperative periprosthetic fracture	35	4872	Risk Ratio (M-H, Random, 95% CI)	2.94 [1.65, 5.24]
4.1.1 Published before 2010	27	4049	Risk Ratio (M-H, Random, 95% CI)	3.19 [1.72, 5.93]
4.1.2 Published from 2010 onwards	8	823	Risk Ratio (M-H, Random, 95% CI)	1.67 [0.34, 8.35]
4.2 Postoperative periprosthetic fracture	46	7021	Risk Ratio (M-H, Random, 95% CI)	3.62 [2.07, 6.33]
4.2.1 Published before 2010	30	4059	Risk Ratio (M-H, Random, 95% CI)	4.43 [2.12, 9.26]
4.2.2 Published from 2010 onwards	16	2962	Risk Ratio (M-H, Random, 95% CI)	2.77 [1.18, 6.51]

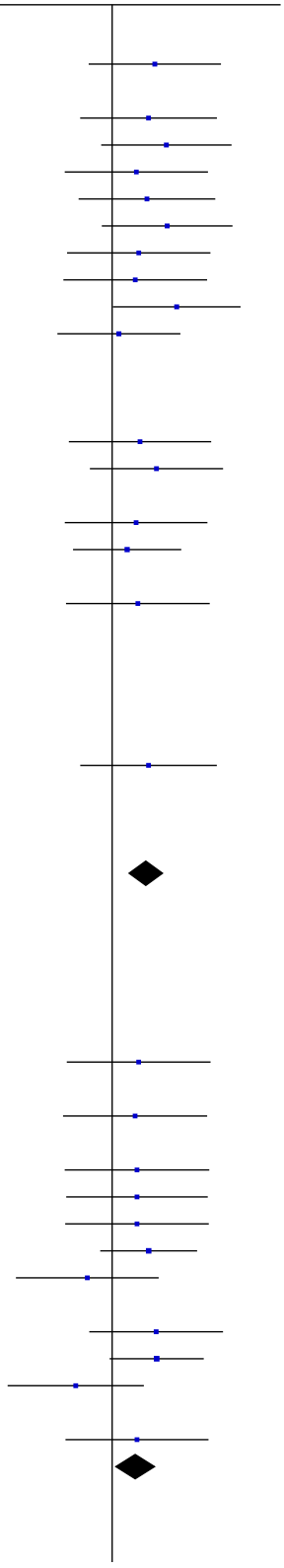
Analysis 4.1. Comparison 4: Intraoperative and postoperative periprosthetic fractures: subgrouped by year of publication, Outcome 1: Intraoperative periprosthetic fracture

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
4.1.1 Published before 2010						
Bridle 1991	1	49	0	51	3.3%	3.12 [0.13 , 74.80]
Guyer 1991	1	50	0	50	3.3%	3.00 [0.13 , 71.92]
Leung 1992	3	93	2	93	10.7%	1.50 [0.26 , 8.77]
Mott 1993	3	35	0	34	3.9%	6.81 [0.36 , 127.00]
Radford 1993	6	100	1	100	7.6%	6.00 [0.74 , 48.94]
Ahrengart 1994	0	105	1	104	3.3%	0.33 [0.01 , 8.01]
Goldhagen 1994	0	36	0	39		Not estimable
Benum 1994	4	226	0	234	3.9%	9.32 [0.50 , 172.07]
O'Brien 1995	2	53	0	49	3.7%	4.63 [0.23 , 94.10]
Hoffman 1996	1	31	0	36	3.3%	3.47 [0.15 , 82.21]
Kukla 1997	0	60	0	60		Not estimable
Hardy 1998	3	50	0	50	3.9%	7.00 [0.37 , 132.10]
Park 1998	0	30	0	30		Not estimable
Kuwabara 1998	0	20	0	23		Not estimable
Baumgaertner 1998	2	67	0	68	3.7%	5.07 [0.25 , 103.74]
Hoffmann 1999	2	56	0	54	3.7%	4.82 [0.24 , 98.24]
Mehdi 2000	0	90	0	90		Not estimable
Pelet 2001	1	13	0	13	3.4%	3.00 [0.13 , 67.51]
Adams 2001	2	203	0	197	3.6%	4.85 [0.23 , 100.45]
Lopez 2002	0	43	0	60		Not estimable
Harrington 2002	1	50	0	52	3.3%	3.12 [0.13 , 74.78]
Saudan 2002	0	100	0	106		Not estimable
Papasimos 2005	1	80	0	40	3.3%	1.52 [0.06 , 36.46]
Miedel 2005	3	109	0	108	3.8%	6.94 [0.36 , 132.70]
Utrilla 2005	4	104	2	106	11.9%	2.04 [0.38 , 10.89]
Ovesen 2006	0	73	0	73		Not estimable
Ekstrom 2007	1	105	0	98	3.3%	2.80 [0.12 , 67.98]
Subtotal (95% CI)		**2031**		**2018**	**87.1%**	**3.19 [1.72 , 5.93]**
Total events:	41		6			
Heterogeneity: Tau² = 0.00; Chi² = 5.15, df = 18 (P = 1.00); I² = 0%						
Test for overall effect: Z = 3.67 (P = 0.0002)						
4.1.2 Published from 2010 onwards						
Verettas 2010	2	59	1	59	5.9%	2.00 [0.19 , 21.46]
Xu 2010	2	51	0	55	3.7%	5.38 [0.26 , 109.55]
Barton 2010	0	100	0	110		Not estimable
Hong 2011	0	10	0	10		Not estimable
Kouvidis 2012	0	86	0	79		Not estimable
Zhou 2012	0	36	0	28		Not estimable
Aktselis 2014	0	40	1	40	3.3%	0.33 [0.01 , 7.95]
Sharma 2018	0	31	0	29		Not estimable
Subtotal (95% CI)		**413**		**410**	**12.9%**	**1.67 [0.34 , 8.35]**
Total events:	4		2			
Heterogeneity: Tau² = 0.00; Chi² = 1.59, df = 2 (P = 0.45); I² = 0%						
Test for overall effect: Z = 0.63 (P = 0.53)						
Total (95% CI)		**2444**		**2428**	**100.0%**	**2.94 [1.65 , 5.24]**
Total events:	45		8			
Heterogeneity: Tau² = 0.00; Chi² = 7.28, df = 21 (P = 1.00); I² = 0%						
Test for overall effect: Z = 3.65 (P = 0.0003)						
Test for subgroup differences: Chi² = 0.54, df = 1 (P = 0.46), I² = 0%						



Analysis 4.2. Comparison 4: Intraoperative and postoperative periprosthetic fractures: subgrouped by year of publication, Outcome 2: Postoperative periprosthetic fracture

Study or Subgroup	Cephalomedullary Events	Cephalomedullary Total	Extramedullary Events	Extramedullary Total	Weight	Risk Ratio M-H, Random, 95% CI
4.2.1 Published before 2010						
Bridle 1991	3	34	0	32	3.6%	6.60 [0.35 , 122.96]
Guyer 1991	0	50	0	50		Not estimable
Leung 1992	2	93	0	93	3.4%	5.00 [0.24 , 102.75]
Radford 1993	5	100	0	100	3.8%	11.00 [0.62 , 196.33]
Mott 1993	1	35	0	34	3.1%	2.92 [0.12 , 69.20]
Ahrengart 1994	2	87	0	81	3.4%	4.66 [0.23 , 95.61]
Benum 1994	5	226	0	234	3.7%	11.39 [0.63 , 204.76]
Goldhagen 1994	1	36	0	39	3.1%	3.24 [0.14 , 77.15]
O'Brien 1995	1	53	0	49	3.1%	2.78 [0.12 , 66.62]
Butt 1995	8	47	0	48	3.9%	17.35 [1.03 , 292.39]
Hoffman 1996	1	23	1	31	4.2%	1.35 [0.09 , 20.44]
Kukla 1997	0	45	0	44		Not estimable
Hardy 1998	0	50	0	50		Not estimable
Park 1998	0	30	0	30		Not estimable
Kuwabara 1998	1	20	0	23	3.2%	3.43 [0.15 , 79.74]
Baumgaertner 1998	3	67	0	68	3.6%	7.10 [0.37 , 134.92]
Hoffmann 1999	0	56	0	54		Not estimable
Michos 2001	1	25	0	24	3.1%	2.88 [0.12 , 67.53]
Adams 2001	2	203	1	197	5.4%	1.94 [0.18 , 21.23]
Lopez 2002	0	30	0	38		Not estimable
Harrington 2002	1	50	0	52	3.1%	3.12 [0.13 , 74.78]
Miedel 2005	0	109	0	108		Not estimable
Utrilla 2005	0	82	0	81		Not estimable
Pajarinen 2005	0	54	0	54		Not estimable
Giraud 2005	0	34	0	26		Not estimable
Papasimos 2005	0	80	0	40		Not estimable
Ovesen 2006	2	73	0	73	3.4%	5.00 [0.24 , 102.38]
Ekstrom 2007	0	105	0	98		Not estimable
Little 2008	0	92	0	98		Not estimable
Zou 2009	0	58	0	63		Not estimable
Subtotal (95% CI)		**2047**		**2012**	**57.2%**	**4.43 [2.12 , 9.26]**
Total events:	39		2			
Heterogeneity: Tau² = 0.00; Chi² = 3.59, df = 15 (P = 1.00); I² = 0%						
Test for overall effect: Z = 3.95 (P < 0.0001)						
4.2.2 Published from 2010 onwards						
Barton 2010	0	100	0	110		Not estimable
Xu 2010	1	51	0	55	3.1%	3.23 [0.13 , 77.56]
Hong 2011	0	10	0	10		Not estimable
Kouvidis 2012	1	86	0	79	3.1%	2.76 [0.11 , 66.75]
Zhou 2012	0	36	0	27		Not estimable
Parker 2012	1	300	0	300	3.1%	3.00 [0.12 , 73.35]
Calderon 2013	1	16	0	16	3.2%	3.00 [0.13 , 68.57]
Gou 2013	1	45	0	45	3.1%	3.00 [0.13 , 71.74]
Matre 2013	5	341	1	343	6.8%	5.03 [0.59 , 42.82]
Chechik 2014	0	26	1	26	3.1%	0.33 [0.01 , 7.82]
Aktselis 2014	0	36	0	35		Not estimable
Parker 2017	3	200	0	200	3.6%	7.00 [0.36 , 134.64]
Sanders 2017	7	123	1	126	7.2%	7.17 [0.90 , 57.43]
Xu 2018	0	50	2	50	3.4%	0.20 [0.01 , 4.06]
Sharma 2018	0	31	0	29		Not estimable
Singh 2019	1	30	0	30	3.1%	3.00 [0.13 , 70.83]
Subtotal (95% CI)		**1481**		**1481**	**42.8%**	**2.77 [1.18 , 6.51]**
Total events:	21		5			
Heterogeneity: Tau² = 0.00; Chi² = 6.16, df = 10 (P = 0.80); I² = 0%						
Test for overall effect: Z = 2.34 (P = 0.02)						

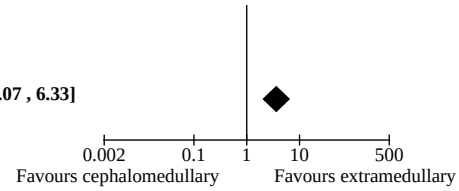


Analysis 4.2. (Continued)

Heterogeneity: Tau² = 0.00; Chi² = 6.16, df = 10 (P = 0.80); I² = 0%
Test for overall effect: Z = 2.34 (P = 0.02)

Total (95% CI)		**3528**	**3493**	**100.0%**	**3.62 [2.07 , 6.33]**
Total events:	60		7		

Heterogeneity: Tau² = 0.00; Chi² = 10.29, df = 26 (P = 1.00); I² = 0%
Test for overall effect: Z = 4.52 (P < 0.00001)
Test for subgroup differences: Chi² = 0.66, df = 1 (P = 0.42), I² = 0%



ADDITIONAL TABLES

Table 1. Extramedullary devices evaluated by included trials

Name	Description
Sliding hip screw (SHS)	The SHS (DePuy Synthes) consists of a lag screw passed up the femoral neck to the femoral head. This lag screw is then attached to a plate on the side of the femur typically at 135° (130° to 150° available). These are considered 'dynamic' implants as they have the capacity for sliding at the plate/screw junction to allow for controlled collapse at the fracture site, thereby facilitating fracture healing.
Medoff sliding plate	The Medoff sliding plate (Swemac Ltd) is a modification of the sliding hip screw, the difference being the plate having an inner and outer sleeve, which can slide between each other. This creates an additional capacity for sliding to occur at the level of the lesser trochanter as well as at the lag screw. Sliding at the lag screw can be prevented with a locking screw to create a 'one way' sliding Medoff instead of a 'two way' sliding Medoff. At a later date the locking device on the lag screw can be removed to 'dynamise' the fracture.
Percutaneous compression plate (PCCP)	The PCCP (Orthofix) is an extramedullary device developed by Gotfried in the late 1990s. Similar to the SHS, it utilises a telescoping mechanism in the femoral neck to facilitate collapse of the fracture. It differs in that it is minimally invasive (inserted by 2 small incisions) and uses 2 small screws in the femoral head as opposed to one large screw (SHS). This design is to provide double axis fixation to prevent femoral neck rotation and also prevent damage to the lateral femoral cortex as 2 small screws are used.
Dynamic condylar screw (DCS)	The DCS (DePuy Synthes) device is similar to the SHS device described above. It consists of a lag screw placed in the femoral head that attaches to a plate on the side of the femur via a barrel. It differs however in the angle the lag screw is attached to the plate (95°). This acute angle means that the DCS is most likely to act as a static device with little or no movement taking place at the screw/barrel junction.
Proximal femoral locking plate (PFLP)	The PFLP (DePuy Synthes) device is a pre-contoured fixed angle device where multiple screws (7.3 mm and 5 mm) are placed in the femoral head and fixed to a pre-contoured 4.5 mm plate with a locking mechanism. This ensures it acts as a static device that does not allow movement at the fracture site.
Reverse distal femoral less invasive stabilisation system plate (rDF LISS)	The rDF LISS plate (DePuy Synthes) is a pre-contoured fixed angle devices used for distal femoral fractures. It is essentially a locking plate that can be applied using a minimally invasive technique. It has been used for contralateral proximal femoral fractures by reversing the plate position and placing it on the proximal femur (Zhou 2012).
Reverse distal femoral locking compression plate (rDFLP)	The rDFLP (Greens Surgical, India) is a pre-contoured fixed angle device designed for distal femoral fractures. It has combination holes in the area of the plate placed on the femoral shaft allowing locked and non-locked screw placement. It can be used for contralateral proximal femoral fractures by reversing the plate position and placing it on the proximal femur (Haq 2014).

Table 1. Extramedullary devices evaluated by included trials *(Continued)*

Blade plate	The blade plate is a fixed-angle device where the blade (attached to a plate) is placed in the centre of the femoral head. The angle at the blade/plate junction is typically 95% with plate lengths of 50 mm to 80 mm.

Table 2. Cephalomedullary nails evaluated by the included trials

Name	Description
Gamma nail	The Gamma nail (Stryker) was introduced in the late 1980s for the treatment of extracapsular hip fractures. The implant consists of a sliding lag screw which passes through a short cephalomedullary nail. One or two screws may be passed through the nail tip to secure it to the femoral shaft (distal locking). Theoretical advantages of this implant are due to a percutaneous insertion technique and include reduced blood loss, reduced sepsis, minimal tissue trauma and reduced operating time. Modifications to the design of the Gamma nail and its instrumentation have occurred since its introduction. The long Gamma nail has a range of different lengths from 280 mm to 460 mm with two distal locking screws.
Gamma 3 nail	The Gamma 3 nail (Stryker) is the third generation of the gamma nail fixation system for proximal femoral fractures. It is a trochanteric entry nail with a reduced proximal nail diameter (15.5 mm versus 17 mm) to facilitate a shorter incision. Its length options range from 280 mm to 460 mm. Its neck-shaft angle options include 120°, 125° and 130°. The lag screw shape has also been modified to provide superior cutting behaviour and greater resistance to cut-out.
Intramedullary hip screw (IMHS)	The IMHS (Smith & Nephew), length 210 mm, was introduced in 1991 for the treatment of extracapsular femoral fractures. Like the Gamma nail, it consists of a nail inserted via the greater trochanter into the medullary cavity. It utilises a single screw in the femoral head that can slide through a barrel in the nail allowing fracture compression. Three different neck angles are available: 125°, 130° and 135°. Nail lengths are available from 195 mm to 440 mm.
Proximal femoral nail (PFN)	The PFN (DePuy Synthes), length 240 mm, was introduced in 1998 for the treatment of extracapsular fractures. Like the Gamma and IMHS, it consists of a nail inserted via the greater trochanter into the medullary cavity. Three lengths are available: 240 mm, 200 mm and an ultra-short 180 mm. Two proximal lag screws are passed up the femoral neck to the head. Distal locking can performed in static or dynamic mode via two distal locking screws.
Proximal femoral nail antirotation (PFNA)	The PFNA (DePuy Synthes), length 170 mm, 200 mm or 240 mm, is a modification of the PFN. It is similar to the PFN apart from not having two proximal lag screws but instead a single helically-shaped blade which is designed to provide increased angular and rotational stability. The helical blade is designed to avoid bone loss that occurs during drilling and insertion of a standard hip screw. It has 2 distal locking screw options for either dynamic or static locking. Blade-shaft angle options include 125°, 130° and 135°.
Targon proximal femoral nail (PF)	The Targon PF (B. Braun), length 220 mm, is inserted into the intramedullary cavity via a trochanteric entry point. Proximally, this nail has a sliding lag screw and an antirotation pin. The Targon PF facilitates fracture dynamisation via a gliding screw that glides through a sleeve that is attached to the nail, thereby avoiding protrusion of the screw into peritrochanteric tissues.
Holland nail	The Holland nail (Zimmer Biomet) is like the Gamma and IMHS; it consists of a nail inserted via the greater trochanter in to the medullary cavity. Two proximal lag screws are passed up the femoral neck to the head.
Experimental nail (reported in Dujardin 2001)	An experimental mini-invasive static intramedullary nail, which is not commercially available, is reported in Dujardin 2001. This consists of an intramedullary nail which is 170 mm long with a distal diameter of 12 mm and a proximal diameter of 13 mm. There are two five-mm distal locking holes. The proximal hold of the femur is with two 7-mm cannulated screws which diverge at a 30-degree

Table 2. Cephalomedullary nails evaluated by the included trials *(Continued)*

	angle. Unlike the other proximal femoral nails, there is no sliding mechanism within the nail construct.
Kuntscher-Y nail	The Kuntscher-Y nail (Cuthbert 1976) is an early design of an intramedullary nail. It consists of a side arm and a separate slotted Kuntscher nail. The side arm is passed up the femoral neck, and then attached to an alignment jig to enable a slotted Kuntscher nail to be passed via the greater trochanter through a hole in the side arm and distally within the medullary cavity. The assembled implant construct has no capacity for sliding at the side arm and neither has it the capacity for distal locking.
Endovis nail	The Endovis nail (Citieffe) is available in 3 sizes (195 mm to 400 mm) and has a neck shaft angle of 130°. It has two cephalic screws for the femoral head to facilitate fracture compression. The distal section is slotted to produce a graduated variation of stiffness.
TRIGEN INTERTAN nail	The INTERTAN nail (Smith & Nephew) uses 2 cephalocervical screws in an integrated mechanism allowing intraoperative compression and rotational stability of the head-neck fragments. It has a cannulated set screw mechanism that allows for the device to be used in fixed angle mode or in sliding/compression mode. Its length ranges from 18 cm to 46 cm (long nail option).
Russell-Taylor Recon nail	The Russel-Taylor Recon nail (Smith & Nephew) is an intramedullary nail that utilises a piriformis entry point. Two screws are available for fixation in the femoral head. It is a full length femoral nail with no short versions available for proximal femoral fixation only.
Trochanteric Fixation Nail (TFN)	The TFN nail (DePuy Synthes) is a titanium nail that utilises a helical blade for fixation in the femoral head instead of a lag screw. This design is intended to improve resistance to various collapse and improved rotational control of the medial fracture segment theoretically reducing the rate of cut-out.

Table 3. Effects of other important outcomes

Outcome	Number of studies	Studies	Participants	Effect estimate
Pain, early (≤ 4 months) Mean scores, using VAS, Salvati and Wilson scores, JOA scores; we inverted data in analysis where appropriate so that lower scores indicating less pain Follow-up: at 4 weeks, 6 weeks, and 3 months	4	Dujardin 2001; Matre 2013; Parker 2017; Yamauchi 2014	832	SMD -0.13, 95% CI -0.43 to 0.17, favours cephalomedullary implants; I^2 = 67%; Analysis 1.28
Pain, early (≤ 4 months) Number of people experiencing pain Follow-up: during postoperative period, and at 3 and 4 months	4	Aktselis 2014; Guyer 1991; Hoffmann 1999; Zehir 2015	417	RR 0.79, 95% CI 0.42 to 1.46, favours cephalomedullary implants; I^2 = 63%; Analysis 1.29
Pain at 12 months Mean scores, using VAS, HHS subscore; we invert-	6	Chechik 2014; Li 2018; Matre 2013; Parker 2017; Sadowski 2002; Saudan 2002	1025	We did not pool these data because of substantial statistical heterogeneity (I^2 = 96%)

Table 3. Effects of other important outcomes *(Continued)*

ed data in analysis where appropriate so that lower scores indicate less pain Follow-up: at 12 months and 18 months				
Pain at 12 months Number of people experiencing pain Follow-up: at 6 months and 12 months	10	Ahrengart 1994; Aktselis 2014; Baumgaertner 1998; Calderon 2013; Carulli 2017; Hardy 1998; Leung 1992; Parker 2012; Pelet 2001; Utrilla 2005	952	RR 1.00, 95% CI 0.75 to 1.36, favours extramedullary implants; I^2 = 26%; Analysis 1.31
Length of hospital stay	26	Aktselis 2014; Barton 2010; Baumgaertner 1998; Carulli 2017; Chechik 2014; Chen 2018; Dujardin 2001; Gou 2013; Harrington 2002; Hoffman 1996; Kouvidis 2012; Kukla 1997; Leung 1992; O'Brien 1995; Ovesen 2006; Pajarinen 2005; Parker 2012; Parker 2017; Sadowski 2002; Saudan 2002; Singh 2017; Tao 2013; Varela-Egocheaga 2009; Xu 2010; Xu 2018; Zehir 2015	3647	MD -0.52 days, 95% CI -1.23 to 0.18, favours cephalomedullary; I^2 = 79%; Analysis 1.32
Discharge destination Number of people discharged to own home or to previous residence	14	Baumgaertner 1998; Carulli 2017; Haynes 1996; Hoffmann 1999; Miedel 2005; Pajarinen 2005; Parker 2012; Parker 2017; Pelet 2001; Sadowski 2002; Sanders 2017; Saudan 2002; Varela-Egocheaga 2009; Zehir 2015	2451	RR 1.00, 95% CI 0.96 to 1.04, favours extramedullary implants; I^2 = 0%; Analysis 1.32

CI: confidence interval; HHS: Harris Hip Score; JOA: Japanese Orthopaedic Association; MD: mean difference; RR: risk ratio: SMD: standardised mean difference: VAS: visual analogue scale

Table 4. Adverse events related to implant, fracture, or both

Outcome	Number of studies	Studies	Participants	Effect estimate; Analysis 1.34
Intraoperative periprosthetic fracture	35	Adams 2001; Ahrengart 1994; Aktselis 2014; Barton 2010; Baumgaertner 1998; Benum 1994; Bridle 1991; Ekstrom 2007; Goldhagen 1994; Guyer 1991; Hardy 1998; Harrington 2002; Hoffman 1996; Hoffmann 1999; Hong 2011; Kouvidis 2012; Kukla 1997; Kuwabara 1998; Leung 1992; Lopez 2002; Mehdi 2000; Miedel 2005; Mott 1993; O'Brien 1995; Ovesen 2006; Papasimos 2005; Park 1998; Pelet 2001; Radford 1993; Saudan 2002; Sharma 2018; Utrilla 2005; Verettas 2010; Xu 2010; Zhou 2012	4872	RR 2.94, 95% CI 1.65 to 5.24, favours extramedullary implants; I^2 = 0%
Postoperative periprosthetic fracture	46	Adams 2001; Ahrengart 1994; Aktselis 2014; Barton 2010; Baumgaertner 1998; Benum 1994; Bridle 1991; Butt 1995; Calderon 2013; Chechik 2014; Ekstrom 2007; Giraud 2005; Goldhagen 1994; Gou	7021	RR 3.62, 95% CI 2.07 to 6.33, favours ex-

Table 4. Adverse events related to implant, fracture, or both *(Continued)*

		2013; Guyer 1991; Hardy 1998; Harrington 2002; Hoffman 1996; Hoffmann 1999; Hong 2011; Kouvidis 2012; Kukla 1997; Kuwabara 1998; Leung 1992; Little 2008; Lopez 2002; Matre 2013; Michos 2001; Miedel 2005; Mott 1993; O'Brien 1995; Ovesen 2006; Pajarinen 2005; Papasimos 2005; Park 1998; Parker 2012; Parker 2017; Radford 1993; Sanders 2017; Sharma 2018; Singh 2019; Utrilla 2005; Xu 2010; Xu 2018; Zhou 2012; Zou 2009		tramedullary implants; I^2 = 0%
Loosening of prosthesis	3	Li 2018; Raimondo 2012; Singh 2017	195	RR 0.57, 95% CI 0.12 to 2.76, favours cephalomedullary implants; I^2 = 0%
Cut-out	49	Adams 2001; Ahrengart 1994; Aktselis 2014; Barton 2010; Baumgaertner 1998; Benum 1994; Bridle 1991; Chechik 2014; Davis 1988; Ekstrom 2007; Giraud 2005; Goldhagen 1994; Guyer 1991; Hardy 1998; Harrington 2002; Haynes 1996; Hoffman 1996; Hong 2011; Kouvidis 2012; Kukla 1997; Kuwabara 1998; Leung 1992; Little 2008; Lopez 2002; Matre 2013; Mehdi 2000; Michos 2001; Miedel 2005; Mott 1993; O'Brien 1995; Ovesen 2006; Pajarinen 2005; Papasimos 2005; Park 1998; Parker 2012; Parker 2017; Pelet 2001; Radford 1993; Reindl 2015; Sadowski 2002; Saudan 2002; Singh 2019; Utrilla 2005; Varela-Egocheaga 2009; Xu 2010; Xu 2018; Zehir 2015; Zhou 2012; Zou 2009	7843	RR 0.93, 95% CI 0.71 to 1.22, favours cephalomedullary implants; I^2 = 0%
Implant failure	24	Adams 2001; Adeel 2020; Aktselis 2014; Andalib 2020; Barton 2010; Butt 1995; Cai 2016; Carulli 2017; Chechik 2014; Davis 1988; Kukla 1997; Little 2008; O'Brien 1995; Pelet 2001; Radford 1993; Sadowski 2002; Sanders 2017; Saudan 2002; Sharma 2018; Utrilla 2005; Xu 2010; Xu 2018; Zhou 2012; Zou 2009	3190	RR 0.81, 95% CI 0.55 to 1.20, favours cephalomedullary implants; I^2 = 0%
Deep infection	35	Adams 2001; Ahrengart 1994; Aktselis 2014; Andalib 2020; Barton 2010; Cai 2016; Davis 1988; Giraud 2005; Guyer 1991; Hardy 1998; Hoffman 1996; Hoffmann 1999; Kukla 1997; Leung 1992; Little 2008; Matre 2013; Mehdi 2000; Miedel 2005; Mott 1993; O'Brien 1995; Ovesen 2006; Pajarinen 2005; Park 1998; Parker 2012; Parker 2017; Pelet 2001; Radford 1993; Reindl 2015; Sadowski 2002; Saudan 2002; Singh 2017; Utrilla 2005; Zehir 2015; Zhou 2012; Zou 2009	6184	RR 0.76, 95% CI 0.41 to 1.38. favours cephalomedullary implants; I^2 = 0%
Superficial infection	35	Adams 2001; Adeel 2020; Andalib 2020; Bridle 1991; Butt 1995; Cai 2016; Carulli 2017; Chechik 2014; Davis 1988; Eceviz 2020; Ekstrom 2007; Gou 2013; Kouvidis 2012; Kuwabara 1998; Lopez 2002; Little 2008; Miedel 2005; O'Brien 1995; Pajarinen 2005; Papasimos 2005; Parker 2012; Parker 2017; Radford 1993; Rahme 2007; Raimondo 2012; Sharma 2018; Singh 2017; Singh 2019; Utrilla 2005; Verettas 2010; Xu 2010; Xu 2018; Zehir 2015; Zhou 2012; Zou 2009	5087	RR 0.71, 95% CI 0.53 to 0.96, favours cephalomedullary implants; I^2 = 0%

Table 4. Adverse events related to implant, fracture, or both *(Continued)*

Non-union	40	Adeel 2020; Ahrengart 1994; Aktselis 2014; Andalib 2020; Barton 2010; Baumgaertner 1998; Cai 2016; Calderon 2013; Dujardin 2001; Ekstrom 2007; Giraud 2005; Goldhagen 1994; Gou 2013; Haq 2014; Hardy 1998; Harrington 2002; Hong 2011; Kouvidis 2012; Kukla 1997; Leung 1992; Li 2018; Little 2008; Michos 2001; Ovesen 2006; Papasimos 2005; Park 1998; Parker 2012; Parker 2017; Pelet 2001; Radford 1993; Rahme 2007; Sadowski 2002; Saudan 2002; Sharma 2018; Singh 2017; Singh 2019; Tao 2013; Xu 2010; Zhou 2012; Zou 2009	4959	RR 0.55, 95% CI 0.32 to 0.96, favours cephalomedullary implants ; I^2 = 0%

CI: confidence interval; RR: risk ratio

Table 5. Adverse events unrelated to implant, fracture, or both

Outcome	Number of studies	Studies	Number of participants	Effect estimate; Analysis 1.35
Acute kidney injury	2	Parker 2012; Parker 2017	1000	RR 1.19, 95% CI 0.34 to 4.19, favours extramedullary implants; I^2 = 0%
Blood transfusion	17	Adams 2001; Barton 2010; Harrington 2002; Little 2008; Matre 2013; Ovesen 2006; Parker 2012Parker 2017; Raimondo 2012; Sadowski 2002; Saudan 2002; Sharma 2018; Utrilla 2005; Verettas 2010; Xu 2010; Yamauchi 2014	3726	RR 0.87, 95% CI 0.74 to 1.03, favours cephalomedullary implants; I^2 = 76%
Cerebrovascular accident	11	Bridle 1991; Butt 1995; Chechik 2014; Gou 2013; Hoffman 1996; Parker 2012; Parker 2017; Sadowski 2002; Varela-Egocheaga 2009; Xu 2010; Zhou 2012	2000	RR 1.41, 95% CI 0.61 to 3.24, favours cephalomedullary implants; I^2 = 0%
Chest infection/pneumonia	25	Bridle 1991; Butt 1995; Cai 2016; Carulli 2017; Davis 1988; Giraud 2005; Gou 2013; Hardy 1998; Hoffman 1996; Hoffmann 1999; Kukla 1997; Little 2008; Lopez 2002; Mott 1993; O'Brien 1995; Papasimos 2005; Parker 2012; Parker 2017; Sadowski 2002; Saudan 2002; Singh 2019; Tao 2013; Varela-Egocheaga 2009; Xu 2010; Zehir 2015	3657	RR 1.05, 95% CI 0.80 to 1.39, favours extramedullary implants; I^2 = 0%
Myocardial infarction/acute coronary syndrome	11	Butt 1995; Chechik 2014; Gou 2013; Hardy 1998; Hoffman 1996; Parker 2012; Parker 2017; Sadowski 2002; Saudan 2002; Varela-Egocheaga 2009; Zhou 2012	1800	RR 0.77, 95% CI 0.44 to 1.35, favours cephalomedullary implants; I^2 = 0%
Urinary tract infection	16	Butt 1995; Cai 2016; Carulli 2017; Davis 1988; Hardy 1998; Hoffman 1996; Lopez 2002; O'Brien 1995; Papasimos 2005; Sadowski 2002; Saudan 2002; Tao 2013; Varela-Egocheaga 2009; Xu 2010; Zehir 2015	1943	RR 1.06, 95% CI 0.79 to 1.41, favours extramedullary implants; I^2 = 11%
Deep vein thrombosis	30	Adams 2001; Ahrengart 1994; Butt 1995; Carulli 2017; Davis 1988; Giraud 2005; Gou 2013;	4589	RR 1.07, 95% CI 0.76 to 1.49, favours ex-

Table 5. Adverse events unrelated to implant, fracture, or both *(Continued)*

		Hardy 1998; Hoffman 1996; Hoffmann 1999; Kukla 1997; Li 2018; Little 2008; Lopez 2002; Mott 1993; Pajarinen 2005; Papasimos 2005; Parker 2012; Parker 2017; Radford 1993; Sadowski 2002; Saudan 2002; Sharma 2018; Singh 2019; Tao 2013; Utrilla 2005; Verettas 2010; Zehir 2015; Zhou 2012; Zou 2009		tramedullary implants; I^2 = 0%
Pulmonary embolism	14	Bridle 1991; Carulli 2017; Hardy 1998; Kukla 1997; Little 2008; O'Brien 1995; Papasimos 2005; Parker 2012; Parker 2017; Pelet 2001; Sadowski 2002; Saudan 2002; Xu 2010; Zehir 2015	2434	RR 1.27, 95% CI 0.54 to 3.03, favours extramedullary implants; I^2 = 0%

CI: confidence interval; RR: risk ratio

APPENDICES

Appendix 1. Search strategies

CENTRAL (CRS-Web)

#1 MESH DESCRIPTOR Femoral Fractures EXPLODE ALL AND CENTRAL:TARGET
#2 ((hip or hips or cervical) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#3 ((femoral* or femur* or acetabul*) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#5 ((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#6 ((head or neck or proximal) NEAR5 (fracture* or break* or broke*)) and (femoral* or femur*) AND CENTRAL:TARGET
#7 #1 OR #2 OR #3 OR #4 OR #5 OR #6 AND CENTRAL:TARGET
#8 MESH DESCRIPTOR Arthroplasty, Replacement, Hip AND CENTRAL:TARGET
#9 MESH DESCRIPTOR Hip Prosthesis AND CENTRAL:TARGET
#10 MESH DESCRIPTOR Arthroplasty, Replacement AND CENTRAL:TARGET
#11 MESH DESCRIPTOR Hemiarthroplasty AND CENTRAL:TARGET
#12 MESH DESCRIPTOR Joint Prosthesis AND CENTRAL:TARGET
#13 ((arthroplast* or hemiarthroplast*) NEAR5 (hip or hips or femur* or femoral* or acetabul*)) AND CENTRAL:TARGET
#14 ((hip or hips) NEAR5 (replac* or prosthes* or implant*)) AND CENTRAL:TARGET
#15 ((joint* NEAR5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*)) AND CENTRAL:TARGET
#16 #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 AND CENTRAL:TARGET
#17 MESH DESCRIPTOR Fractures, Bone AND CENTRAL:TARGET
#18 MESH DESCRIPTOR Fracture Dislocation EXPLODE ALL AND CENTRAL:TARGET
#19 MESH DESCRIPTOR Fractures, Closed AND CENTRAL:TARGET
#20 MESH DESCRIPTOR Fractures, Comminuted AND CENTRAL:TARGET
#21 MESH DESCRIPTOR Fractures, Compression AND CENTRAL:TARGET
#22 MESH DESCRIPTOR Fractures, Malunited AND CENTRAL:TARGET
#23 MESH DESCRIPTOR Fractures, Multiple AND CENTRAL:TARGET
#24 MESH DESCRIPTOR Fractures, Open AND CENTRAL:TARGET
#25 MESH DESCRIPTOR Fractures, Spontaneous AND CENTRAL:TARGET
#26 MESH DESCRIPTOR Fractures, Stress AND CENTRAL:TARGET
#27 MESH DESCRIPTOR Fractures, Ununited AND CENTRAL:TARGET
#28 MESH DESCRIPTOR Intra-Articular Fractures AND CENTRAL:TARGET
#29 MESH DESCRIPTOR Osteoporotic Fractures AND CENTRAL:TARGET
#30 MESH DESCRIPTOR Periprosthetic Fractures AND CENTRAL:TARGET
#31 fracture* AND CENTRAL:TARGET
#32 #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 AND CENTRAL:TARGET
#33 #32 AND #16 AND CENTRAL:TARGET
#34 (pin or pins or nail or nails or screw or screws or plate or plates) AND CENTRAL:TARGET
#35 MESH DESCRIPTOR Internal Fixators AND CENTRAL:TARGET

#36 MESH DESCRIPTOR Bone Nails AND CENTRAL:TARGET
#37 MESH DESCRIPTOR Bone Plates AND CENTRAL:TARGET
#38 MESH DESCRIPTOR Bone Screws EXPLODE ALL AND CENTRAL:TARGET
#39 (static NEXT (device* or implant*)) AND CENTRAL:TARGET
#40 (dynamic NEXT (device* or implant*)) AND CENTRAL:TARGET
#41 #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 AND CENTRAL:TARGET
#42 ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)) AND CENTRAL:TARGET
#43 (hip or hips or femur* or femoral* or acetabul*) AND CENTRAL:TARGET
#44 #43 AND (#17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30) AND CENTRAL:TARGET
#45 #42 OR #44 AND CENTRAL:TARGET
#46 #41 AND #45 AND CENTRAL:TARGET
#47 #7 OR #33 OR #46 AND CENTRAL:TARGET
#48 14/11/2018_TO_08/07/2020:CRSCREATED AND CENTRAL:TARGET
#49 #47 AND #48

MEDLINE (Ovid)

1 exp Femoral Fractures/
2 ((hip or hips or cervical) adj5 (fracture$ or break$ or broke$)).ti,ab,kf.
3 ((femoral$ or femur$ or acetabul$) adj5 (fracture$ or break$ or broke$)).ti,ab,kf.
4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) adj5 (fracture $ or break$ or broke$)).ti,ab,kf.
5 ((extracapsular or extra-capsular or trochant$ or subtrochant$ or pertrochant$ or intertrochant$) adj5 (fracture$ or break$ or broke $)).ti,ab,kf.
6 (((head or neck or proximal) adj5 (fracture$ or break$ or broke$)) and (femoral$ or femur$)).ti,ab,kf.
7 or/1-6
8 randomized controlled trial.pt.
9 controlled clinical trial.pt.
10 randomized.ab.
11 placebo.ab.
12 clinical trials as topic.sh.
13 randomly.ab.
14 trial.ti.
15 8 or 9 or 10 or 11 or 12 or 13 or 14
16 7 and 15
17 Arthroplasty, Replacement, Hip/ or Hip Prosthesis/
18 Arthroplasty, Replacement/ or Hemiarthroplasty/ or Joint Prosthesis/
19 ((arthroplast$ or hemiarthroplast$) adj5 (hip or hips or femur$ or femoral$ or acetabul$)).ti,ab,kf.
20 ((hip or hips) adj5 (replac$ or prosthes$ or implant$)).ti,ab,kf.
21 ((joint$1 adj5 (replac$ or prosthes$ or implant$)) and (hip or hips or femur$ or femoral$ or acetabul$)).ti,ab,kf.
22 or/17-21
23 fractures, bone/ or exp fracture dislocation/ or fractures, closed/ or fractures, comminuted/ or fractures, compression/ or fractures, malunited/ or fractures, multiple/ or fractures, open/ or fractures, spontaneous/ or exp fractures, stress/ or fractures, ununited/ or intra-articular fractures/ or osteoporotic fractures/ or periprosthetic fractures/
24 fracture$.ti,ab,kf.
25 23 or 24
26 22 and 25 and 15
27 (pin or pins or nail or nails or screw or screws or plate or plates).ti,ab,kf.
28 internal fixators/ or bone nails/ or bone plates/ or exp bone screws/
29 (static adj (device$1 or implant$1)).ti,ab,kf.
30 (dynamic adj (device$1 or implant$1)).ti,ab,kf.
31 or/27-30
32 ((hip or hips or femur$ or femoral$ or acetabul$) and (fracture$ or break$ or broke$)).ti,ab,kf.
33 (hip or hips or femur$ or femoral$ or acetabul$).ti,ab,kf. and (fractures, bone/ or exp fracture dislocation/ or fractures, closed/ or fractures, comminuted/ or fractures, compression/ or fractures, malunited/ or fractures, multiple/ or fractures, open/ or fractures, spontaneous/ or exp fractures, stress/ or fractures, ununited/ or intra-articular fractures/ or osteoporotic fractures/ or periprosthetic fractures/)
34 or/32-33
35 31 and 34 and 15
36 16 or 26 or 35
37 exp animals/ not humans/
38 36 not 37

Embase (Ovid)

1 exp Femur Fractures/ or exp hip fracture/
2 ((hip or hips or cervical) adj5 (fracture$ or break$ or broke$)).ti,ab,kw.
3 ((femoral$ or femur$ or acetabul$) adj5 (fracture$ or break$ or broke$)).ti,ab,kw.
4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) adj5 (fracture $ or break$ or broke$)).ti,ab,kw.
5 ((extracapsular or extra-capsular or trochant$ or subtrochant$ or pertrochant$ or intertrochant$) adj5 (fracture$ or break$ or broke $)).ti,ab,kw.
6 (((head or neck or proximal) adj5 (fracture$ or break$ or broke$)) and (femoral$ or femur$)).ti,ab,kw.
7 or/1-6
8 exp hip surgery/ or (joint surgery/ and exp hip/)
9 exp Hip Prosthesis/
10 joint prosthesis/ and exp hip/
11 Replacement Arthroplasty/ and exp hip/
12 exp Hip arthroplasty/
13 Arthroplasty/ and exp hip/
14 Hemiarthroplasty/ and exp hip/
15 Hip hemiarthroplasty/
16 ((arthroplast$ or hemiarthroplast$) adj5 (hip or hips or femur$ or femoral$ or acetabul$)).ti,ab,kw.
17 ((hip or hips) adj5 (replac$ or prosthes$ or implant$)).ti,ab,kw.
18 ((joint$1 adj5 (replac$ or prosthes$ or implant$)) and (hip or hips or femur$ or femoral$ or acetabul$)).ti,ab,kw.
19 or/8-18
20 fracture/
21 Fracture dislocation/
22 Comminuted fracture/
23 Multiple fracture/
24 Open fracture/
25 Fragility fracture/
26 exp Fracture healing/
27 Stress fracture/
28 intraarticular fracture/
29 periprosthetic fracture/
30 fracture$.ti,ab,kw.
31 or/20-30
32 19 and 31
33 (pin or pins or nail or nails or screw or screws or plate or plates).ti,ab,kw.
34 internal fixator/ or exp bone nail/ or exp bone plate/ or exp bone pin/ or exp bone screw/ or exp femoral fixation device/
35 (static adj (device$1 or implant$1)).ti,ab,kw.
36 (dynamic adj (device$1 or implant$1)).ti,ab,kw.
37or/33-36
38 ((hip or hips or femur$ or femoral$ or acetabul$) and (fracture$ or break$ or broke$)).ti,ab,kw.
39 (hip or hips or femur$ or femoral$ or acetabul$).ti,ab,kw.
40 39 and 31
41 37 and (38 or 40)
42 7 or 32 or 41
43 Randomized controlled trial/
44 Controlled clinical study/
45 Random$.ti,ab.
46 randomization/
47 intermethod comparison/
48 placebo.ti,ab.
49 (compare or compared or comparison).ti.
50 ((evaluated or evaluate or evaluating or assessed or assess) and (compare or compared or comparing or comparison)).ab.
51 (open adj label).ti,ab.
52 ((double or single or doubly or singly) adj (blind or blinded or blindly)).ti,ab.
53 double blind procedure/
54 parallel group$1.ti,ab.
55 (crossover or cross over).ti,ab.
56 ((assign$ or match or matched or allocation) adj5 (alternate or group$1 or intervention$1 or patient$1 or subject$1 or participant $1)).ti,ab.
57 (assigned or allocated).ti,ab.

58 (controlled adj7 (study or design or trial)).ti,ab.
59 (volunteer or volunteers).ti,ab.
60 human experiment/
61 trial.ti.
62 or/43-61
63 (random$ adj sampl$ adj7 ("cross section$" or questionnaire$1 or survey$ or database$1)).ti,ab. not (comparative study/ or controlled study/ or randomi?ed controlled.ti,ab. or randomly assigned.ti,ab.)
64 Cross-sectional study/ not (randomized controlled trial/ or controlled clinical study/ or controlled study/ or randomi?ed controlled.ti,ab. or control group$1.ti,ab.)
65 (((case adj control$) and random$) not randomi?ed controlled).ti,ab.
66 (Systematic review not (trial or study)).ti.
67 (nonrandom$ not random$).ti,ab.
68 "Random field$".ti,ab.
69 (random cluster adj3 sampl$).ti,ab.
70 (review.ab. and review.pt.) not trial.ti.
71 "we searched".ab. and (review.ti. or review.pt.)
72 "update review".ab.
73 (databases adj4 searched).ab.
74 (rat or rats or mouse or mice or swine or porcine or murine or sheep or lambs or pigs or piglets or rabbit or rabbits or cat or cats or dog or dogs or cattle or bovine or monkey or monkeys or trout or marmoset$1).ti. and animal experiment/
75 Animal experiment/ not (human experiment/ or human/)
76 or/63-75
77 62 not 76
78 42 and 77

Web of Science

1 TOPIC: (((hip or hips or cervical) NEAR/5 (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
2 TOPIC: (((femoral* or femur* or acetabul*) NEAR/5 (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
3 TOPIC: (((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) NEAR/5 (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
4 TOPIC: (((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) NEAR/5 (fracture* or break* or broke*))) Indexes=SCIEXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
5 TOPIC: (((head or neck or proximal) NEAR/5 (fracture* or break* or broke*)) and (femoral* or femur*)) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
6 #5 OR #4 OR #3 OR #2 OR #1 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
7 TS=(((arthroplast* or hemiarthroplast*) NEAR/5 (hip or hips or femur* or femoral* or acetabul*)) and fracture*) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
8 TS=(((hip or hips) NEAR/5 (replac* or prosthes* or implant*)) and fracture*) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
9 TS=(((joint* NEAR/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*)) and fracture*) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
10 TS=((pin or pins or nail or nails or screw or screws or plate or plates or fixator*) and ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
11 TS=((“static device*” OR “static implant*”) and ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
12 TS=((“dynamic device*” or “dynamic implant*”) and ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
13 #12 OR #11 OR #10 OR #9 OR #8 OR #7 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
14 #13 OR #6 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
15 TS=(random* or factorial* or crossover* or "cross-over*" or placebo* or "doubl* blind*" or "singl* blind*" or assign* or allocat* or volunteer* or "trial" or "groups" or "controlled") Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
16 #15 AND #14 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
17 #16 Indexes=SCI-EXPANDED, CPCI-S Timespan=1900-2018
18 TI=(RAT OR RATS OR MOUSE OR MOUSE OR DOG OR DOGS OR RABBIT OR RABBITS OR PIG OR PIGS OR SWINE OR PORCINE) Indexes=SCIEXPANDED, CPCI-S Timespan=1900-2020
19 #17 NOT #18 Indexes=SCI-EXPANDED, CPCI-S Timespan=1900-2020

Cochrane Database of Systematic Reviews (CDSR)

#1 MeSH descriptor: [Femoral Fractures] explode all trees

#2 ((hip or hips or cervical) NEAR/5 (fracture* or break* or broke*))
#3 ((femoral* or femur* or acetabul*) NEAR/5 (fracture* or break* or broke*))
#4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) NEAR/5 (fracture* or break* or broke*))
#5 ((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) NEAR/5 (fracture* or break* or broke*))
#6 ((head or neck or proximal) NEAR/5 (fracture* or break* or broke*)) and (femoral* or femur*)
#7 #1 OR #2 OR #3 OR #4 OR #5 OR #6
#8 MeSH descriptor: [Arthroplasty, Replacement, Hip] this term only
#9 MeSH descriptor: [Hip Prosthesis] this term only
#10 MeSH descriptor: [Arthroplasty, Replacement] this term only
#11 MeSH descriptor: [Hemiarthroplasty] this term only
#12 MeSH descriptor: [Joint Prosthesis] this term only
#13 ((arthroplast* or hemiarthroplast*) NEAR/5 (hip or hips or femur* or femoral* or acetabul*))
#14 ((hip or hips) NEAR/5 (replac* or prosthes* or implant*))
#15 ((joint* NEAR/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))
#16 #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15
#17 MeSH descriptor: [Fractures, Bone] this term only
#18 MeSH descriptor: [Fracture Dislocation] explode all trees
#19 MeSH descriptor: [Fractures, Closed] this term only
#20 MeSH descriptor: [Fractures, Comminuted] this term only
#21 MeSH descriptor: [Fractures, Compression] this term only
#22 MeSH descriptor: [Fractures, Malunited] this term only
#23 MeSH descriptor: [Fractures, Multiple] this term only
#24 MeSH descriptor: [Fractures, Open] this term only
#25 MeSH descriptor: [Fractures, Spontaneous] this term only
#26 MeSH descriptor: [Fractures, Stress] explode all trees
#27 MeSH descriptor: [Fractures, Ununited] this term only
#28 MeSH descriptor: [Intra-Articular Fractures] this term only
#29 MeSH descriptor: [Osteoporotic Fractures] this term only
#30 MeSH descriptor: [Periprosthetic Fractures] this term only
#31 fracture*
#32 #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31
#33 #16 AND #32
#34 (pin or pins or nail or nails or screw or screws or plate or plates)
#35 MeSH descriptor: [Internal Fixators] this term only
#36 MeSH descriptor: [Bone Nails] this term only
#37 MeSH descriptor: [Bone Plates] this term only
#38 MeSH descriptor: [Bone Screws] explode all trees
#39 (static NEXT (device* or implant*))
#40 (dynamic NEXT (device* or implant*))
#41 #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40
#42 ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))
#43 (hip or hips or femur* or femoral* or acetabul*)
#44 #43 AND (#17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30)
#45 #42 OR #44
#46 #41 AND #45
#47 #7 OR #33 OR #46 in Cochrane Reviews

Database of Abstracts of Reviews of Effects (DARE)

1 (MeSH DESCRIPTOR Femoral Fractures EXPLODE ALL TREES)
2 ((hip or hips or cervical) near5 (fracture* or break* or broke*))
3 ((fracture* or break* or broke*) near5 (hip or hips or cervical))
4 ((femoral* or femur* or acetabul*) near5 (fracture* or break* or broke*))
5 ((fracture* or break* or broke*) near5 (femoral* or femur* or acetabul*))
6 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) near5 (fracture* or break* or broke*))
7 ((fracture* or break* or broke*) near5 (intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical))
8 ((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near5 (fracture* or break* or broke*))
9 ((fracture* or break* or broke*) near5 (extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*))
10 ((head or neck or proximal) near5 (fracture* or break* or broke*)) AND (femoral* or femur*)

11 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10
12 (MeSH DESCRIPTOR Arthroplasty, Replacement, Hip) OR (MeSH DESCRIPTOR Hip Prosthesis)
13 (MeSH DESCRIPTOR Arthroplasty, Replacement) OR (MeSH DESCRIPTOR Hemiarthroplasty) OR (MeSH DESCRIPTOR Joint Prosthesis)
14 ((arthroplast* or hemiarthroplast*) near5 (hip or hips or femur* or femoral* or acetabul*))
15 ((hip or hips or femur* or femoral* or acetabul*) near5 (arthroplast* or hemiarthroplast*))
16 ((hip or hips) near5 (replac* or prosthes* or implant*))
17 ((replac* or prosthes* or implant*) near5 (hip or hips))
18 (joint* near5 (replac* or prosthes* or implant*)) AND (hip or hips or femur* or femoral* or acetabul*)
19 #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18
20 (MeSH DESCRIPTOR fractures, bone)
21 (MeSH DESCRIPTOR fracture dislocation EXPLODE ALL TREES)
22 (MeSH DESCRIPTOR fractures, closed)
23 (MeSH DESCRIPTOR fractures, comminuted)
24 (MeSH DESCRIPTOR fractures, compression)
25 (MeSH DESCRIPTOR fractures, malunited)
26 (MeSH DESCRIPTOR fractures, open)
27 (MeSH DESCRIPTOR fractures, spontaneous)
28 (MeSH DESCRIPTOR fractures, stress EXPLODE ALL TREES)
29 (MeSH DESCRIPTOR fractures, ununited)
30 (MeSH DESCRIPTOR intra-articular fractures)
31 (MeSH DESCRIPTOR osteoporotic fractures)
32 (MeSH DESCRIPTOR periprosthetic fractures)
33 (MeSH DESCRIPTOR fractures, multiple)
34 (fracture*)
35 #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34
36 #19 AND #35
37 (pin or pins or nail or nails or screw or screws or plate or plates)
38 (MeSH DESCRIPTOR internal fixators)
39 (MeSH DESCRIPTOR bone nails)
40 (MeSH DESCRIPTOR bone plates)
41 (MeSH DESCRIPTOR bone screws EXPLODE ALL TREES)
42 (static near (device* or implant*))
43 ((device* or implant*) near static)
44 (dynamic near (device* or implant*))
45 ((device* or implant*) near dynamic)
46 #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45
47 ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))
48 (hip or hips or femur* or femoral* or acetabul*)
49 (#20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33)
50 #48 AND #49
51 #47 OR #50
52 #46 AND #51
53 #11 OR #36 OR #52
54 * IN DARE
55 #53 AND #54

Health Technology Assessment (HTA)

1 (MeSH DESCRIPTOR Femoral Fractures EXPLODE ALL TREES)
2 ((hip or hips or cervical) near5 (fracture* or break* or broke*))
3 ((fracture* or break* or broke*) near5 (hip or hips or cervical))
4 ((femoral* or femur* or acetabul*) near5 (fracture* or break* or broke*))
5 ((fracture* or break* or broke*) near5 (femoral* or femur* or acetabul*))
6 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) near5 (fracture* or break* or broke*))
7 ((fracture* or break* or broke*) near5 (intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical))
8 ((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near5 (fracture* or break* or broke*))
9 ((fracture* or break* or broke*) near5 (extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*))
10 ((head or neck or proximal) near5 (fracture* or break* or broke*)) AND (femoral* or femur*)
11 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10
12 (MeSH DESCRIPTOR Arthroplasty, Replacement, Hip) OR (MeSH DESCRIPTOR Hip Prosthesis)

13 (MeSH DESCRIPTOR Arthroplasty, Replacement) OR (MeSH DESCRIPTOR Hemiarthroplasty) OR (MeSH DESCRIPTOR Joint Prosthesis)
14 ((arthroplast* or hemiarthroplast*) near5 (hip or hips or femur* or femoral* or acetabul*))
15 ((hip or hips or femur* or femoral* or acetabul*) near5 (arthroplast* or hemiarthroplast*))
16 ((hip or hips) near5 (replac* or prosthes* or implant*))
17 ((replac* or prosthes* or implant*) near5 (hip or hips))
18 (joint* near5 (replac* or prosthes* or implant*)) AND (hip or hips or femur* or femoral* or acetabul*)
19 #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18
20 (MeSH DESCRIPTOR fractures, bone)
21 (MeSH DESCRIPTOR fracture dislocation EXPLODE ALL TREES)
22 (MeSH DESCRIPTOR fractures, closed)
23 (MeSH DESCRIPTOR fractures, comminuted)
24 (MeSH DESCRIPTOR fractures, compression)
25 (MeSH DESCRIPTOR fractures, malunited)
26 (MeSH DESCRIPTOR fractures, open)
27 (MeSH DESCRIPTOR fractures, spontaneous)
28 (MeSH DESCRIPTOR fractures, stress EXPLODE ALL TREES)
29 (MeSH DESCRIPTOR fractures, ununited)
30 (MeSH DESCRIPTOR intra-articular fractures)
31 (MeSH DESCRIPTOR osteoporotic fractures)
32 (MeSH DESCRIPTOR periprosthetic fractures)
33 (MeSH DESCRIPTOR fractures, multiple)
34 (fracture*)
35 #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34
36 #19 AND #35
37 (pin or pins or nail or nails or screw or screws or plate or plates)
38 (MeSH DESCRIPTOR internal fixators)
39 (MeSH DESCRIPTOR bone nails)
40 (MeSH DESCRIPTOR bone plates)
41 (MeSH DESCRIPTOR bone screws EXPLODE ALL TREES)
42 (static near (device* or implant*))
43 ((device* or implant*) near static)
44 (dynamic near (device* or implant*))
45 ((device* or implant*) near dynamic)
46 #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45
47 ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))
48 (hip or hips or femur* or femoral* or acetabul*)
49 (#20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33)
50 #48 AND #49
51 #47 OR #50
52 #46 AND #51
53 #11 OR #36 OR #52
54 * IN HTA
55 #53 AND #54

Epistemonikos

Search 1:
Title/abstract (fracture* or break* or broke) AND Title/abstract (hip or hips or cervical or femoral* or femur* or acetabul* or intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical or extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*)

Search 2: Title/abstract (hip or hips or femur* or femoral* or acetabul*) and (replac* or prosthes* or implant*) and fracture*
OR Title/abstract
(arthroplast* or hemiarthroplast*) and (hip or hips or femur* or femoral* or acetabul*) and fracture*

Search 3: Title/abstract (pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators) AND Title/abstract (hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke)

Proquest DISSERTATIONS AND THESES

S1 ti(((hip or hips or cervical) near/5 (fracture* or break* or broke*))) OR ab(((hip or hips or cervical) near/5 (fracture* or break* or broke*)))
S2 ti(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*))) OR ab(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*)))

S3 ti(((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) near/5 (fracture* or break* or broke*))) OR ab(((intracapsular or intracapsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) near/5 (fracture* or break* or broke*)))
S4 ti(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*))) OR ab(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*)))
S5 ti((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*))) OR ab((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*)))
S6 (ti(((hip or hips or cervical) near/5 (fracture* or break* or broke*))) OR ab(((hip or hips or cervical) near/5 (fracture* or break* or broke*)))) OR (ti(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*))) OR ab(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*)))) OR (ti((((intracapsular or intracapsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) near/5 (fracture* or break* or broke*))) OR ab(((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basicervical) near/5 (fracture* or break* or broke*)))) OR (ti(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*))) OR ab(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*)))) OR (ti((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*))) OR ab((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*))))
S7 ti((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*)) OR ab((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*))
S8 ti((hip or hips) near/5 (replac* or prosthes* or implant*)) OR ab((hip or hips) near/5 (replac* or prosthes* or implant*))
S9 ti(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))) OR ab(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*)))
S10 (ti((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*)) OR ab((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*))) OR (ti((hip or hips) near/5 (replac* or prosthes* or implant*)) OR ab((hip or hips) near/5 (replac* or prosthes* or implant*))) OR (ti(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))) OR ab(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))))
S11 ti(fracture*) OR ab(fracture*)
S12 ((ti((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*)) OR ab((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*))) OR (ti((hip or hips) near/5 (replac* or prosthes* or implant*)) OR ab((hip or hips) 183 near/5 (replac* or prosthes* or implant*))) OR (ti(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))) OR ab(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))))) AND (ti(fracture*) OR ab(fracture*))
S13 ti((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators)) OR ab((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators))
S14 ti(static near (device* or implant*)) OR ab(static near (device* or implant*))
S15 ti(dynamic near (device* or implant*)) OR ab(dynamic near (device* or implant*))
S16 (ti((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators)) OR ab((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators))) OR (ti(static near (device* or implant*)) OR ab(static near (device* or implant*))) OR (ti(dynamic near (device* or implant*)) OR ab(dynamic near (device* or implant*)))
S17 ti((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)) OR ab((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))
S18 ((ti((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators)) OR ab((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators))) OR (ti(static near (device* or implant*)) OR ab(static near (device* or implant*))) OR (ti(dynamic near (device* or implant*)) OR ab(dynamic near (device* or implant*)))) AND (ti((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)) OR ab((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)))
S19 ((ti(((hip or hips or cervical) near/5 (fracture* or break* or broke*))) OR ab(((hip or hips or cervical) near/5 (fracture* or break* or broke*)))) OR (ti(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*))) OR ab(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*)))) OR (ti((((intracapsular or intracapsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) near/5 (fracture* or break* or broke*))) OR ab(((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basicervical) near/5 (fracture* or break* or broke*)))) OR (ti(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*))) OR ab(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*)))) OR (ti((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*))) OR ab((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*))))) OR (((ti((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*)) OR ab((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*))) OR (ti((hip or hips) near/5 (replac* or prosthes* or implant*)) OR ab((hip or hips) near/5 (replac* or prosthes* or implant*))) OR (ti(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))) OR ab(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))))) AND (ti(fracture*) OR ab(fracture*))) OR (((ti((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators)) OR ab((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators))) OR (ti(static near (device* or implant*)) OR ab(static near (device* or implant*))) OR (ti(dynamic near (device* or implant*)) OR ab(dynamic near (device* or implant*)))) AND (ti((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)) OR ab((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))))

National Technical Information Service (NTIS)

Title: hip fractures OR Keyword: hip fractures

Keyword: Hip AND Keyword: Bone fractures

ClinicalTrials.gov

Advanced search limited to intervention studies in Condition or disease

Interventional Studies | (fracture OR fractures OR break OR broke OR broken) AND (hip OR hips OR femoral OR femur OR acetabular OR intracapsular OR intra-capsular OR subcapital OR sub-capital OR transcervical OR trans-cervical OR basicervical OR basi-cervical)

Interventional Studies | (fracture OR fractures OR break OR broke OR broken) AND (extracapsular OR extracapsular OR trochanter OR trochanteric OR subtrochanter OR subtrochanteric OR pertrochanter OR pertochanteric OR intertrochanter OR intertochanteric)

Interventional Studies | (hip OR hips OR femur OR femoral OR acetabular) AND (replace OR replacement OR prosthesis OR prostheses OR implant OR implants) AND (fracture OR fractures OR break OR broke OR broken)

Interventional Studies | (arthroplasty OR hemiarthroplasty) AND (hip OR hips OR femur OR femoral OR acetabular) AND (fracture OR fractures OR break OR broke OR broken)

Appendix 2. Template data extraction form

Methods	*RCT or quasi-randomised; parallel design* **Review comparison group:**
Participants	**Total number of randomised participants:** **Total number of participants that completed the study:** **Inclusion criteria:** **Exclusion criteria:** **Setting:** *type of setting, how many sites & country* **Baseline characteristics** **Intervention group 1** (*specify by name*) • Age (mean (SD)): (±) years • Gender (M/F): • Smoking history (n): • Medication (type, n): • BMI (mean (SD)): (±) kg/m^2 • Comorbidities (type, n): • Mobility assessment/use of walking aids: • Place of residence: • Cognitive status/dementia: • ASA status (I/II/III/IV): • Preoperative waiting time (mean (SD)): (±) hours • Fracture classification (stable/unstable, n): • Additional information: **Intervention 2** (*specify by name*) • Age (mean (SD)): (±) years • Gender (M/F): • Smoking history (n):

(Continued)

- Medication (type, n):
- BMI (mean (SD)): (±) kg/m^2
- Comorbidities (type, n):
- Mobility assessment/use of walking aids:
- Place of residence:
- Cognitive status/dementia:
- ASA status (I/II/III/IV):
- Preoperative waiting time (mean (SD)): (±) hours
- Fracture classification (stable/unstable, n):
- Additional information:

Overall:

- Age (mean (SD)): (±) years
- Gender (M/F):
- Smoking history (n):
- Medication (type, n):
- BMI (mean (SD)): (±) kg/m^2
- Comorbidities (type, n):
- Mobility assessment/use of walking aids:
- Place of residence:
- Cognitive status/dementia:
- ASA status (I/II/III/IV):
- Preoperative waiting time (mean (SD)): (±) hours
- Fracture classification (stable/unstable, n):
- Additional information:

Notes

- *Specify outcomes for which baseline data is not specified*
- *Are prognostic variables comparable between groups?*

Interventions

General details: *to include number of clinicians (and their skills and experience), type of anaesthesia, pre- and postoperative care (e.g. use of prophylactic antibiotics or antithromboembolics), rehabilitation (e.g. time to mobilisation or weight-bearing)*

Intervention group 1: *type of implant (with manufacturer details), description of use; number randomised to group, number of losses (for relevant outcomes, and with reasons for losses), number analysed by review authors for each review outcome*

Intervention group 2: *type of implant (with manufacturer details), description of use; number randomised to group, number of losses (for relevant outcomes, and with reasons for losses), number analysed by review authors for each review outcome*

Notes

- *Specify general details for which information is not specified*

Outcomes

Outcomes measured/reported by study authors:

Outcomes relevant to the review: include measurement tools and time point of measure used in review analysis

Notes

- *Specify outcome data which are not included in the review and reasons for not including these data*

Notes

Funding/sponsor/declarations of interest:

(Continued)

Study dates:	

Appendix 3. Critical outcomes: studies included in analysis or other data tables

Outcome	Analysis	Number of studies	Studies	Additional data presented in Appendix 4 and Appendix 5
ADL, early (≤ 4 months) Mean scores	Analysis 1.1	4	Andalib 2020; Reindl 2015; Sanders 2017; Yamauchi 2014	Aktselis 2014 (Appendix 5)
ADL, early (≤ 4 months) Number of participants able to perform ADL independently	Analysis 1.2	1	Miedel 2005	Pahlpatz 1993 (Appendix 4)
ADL at 12 months Mean scores	Analysis 1.4	8	Aktselis 2014; Andalib 2020; Chechik 2014; Eceviz 2020; Reindl 2015; Sadowski 2002; Sanders 2017; Saudan 2002	-
ADL at 12 months Number of participants able to perform ADL independently	Analysis 1.5	1	Miedel 2005	Pahlpatz 1993 (Appendix 4)
Delirium	Analysis 1.7	4	Hoffmann 1999; Papasimos 2005; Parker 2017; Varela-Egocheaga 2009	-
Functional status, early (≤ 4 months) Mean scores	Analysis 1.8	2	Guerra 2014; Kouvidis 2012	Adams 2001; Raimondo 2012; Sharma 2018 (Appendix 5)
Functional status, early (≤ 4 months) Number of participants with excellent or good function	Analysis 1.9	2	Hoffmann 1999; Xu 2018	-
Functional status at 12 months Mean scores	Analysis 1.10	12	Adeel 2020; Cai 2016; Chechik 2014; Eceviz 2020; Gou 2013; Guerra 2014; Haq 2014; Kouvidis 2012; Li 2018; Singh 2017; Singh 2019; Tao 2013	Adams 2001; Calderon 2013; Papasimos 2005; Raimondo 2012; Sharma 2018 (Appendix 5)

(Continued)

Functional status at 12 months Number of participants with excellent or good function	Analysis 1.11	3	Chen 2018; Xu 2018; Zou 2009	Xu 2018; Zou 2009 (Appendix 4)
HRQoL, early (≤ 4 months) Mean scores	-	-	-	Aktselis 2014 (Appendix 5)
HRQoL at 12 months Mean scores	Analysis 1.12	4	Aktselis 2014; Carulli 2017; Haq 2014; Singh 2019	Aktselis 2014; Eceviz 2020
Mobility, early (≤ 4 months) Number of participants with independent mobility	Analysis 1.13	7	Carulli 2017; Ekstrom 2007; Guyer 1991; Hoffmann 1999; Ovesen 2006; Pajarinen 2005; Park 1998	Ekstrom 2007; Guyer 1991; Hoffmann 1999; Ovesen 2006; Pajarinen 2005; Park 1998 (Appendix 4)
Mobility, early (≤ 4 months) Mean scores	Analysis 1.17	1	Reindl 2015	
Mobility, early (≤ 4 months) 10 metre walking speed	Analysis 1.15	1	Li 2018	
Mobility, early (≤ 4 months) Number of participants able to complete a TUG	Analysis 1.16	1	Sanders 2017	
Mobility at 12 months Mean scores	Analysis 1.18	14	Aktselis 2014; Chechik 2014; Gou 2013; Han 2012; Haq 2014; Hardy 1998; Little 2008; Reindl 2015; Sadowski 2002; Saudan 2002; Singh 2019; Utrilla 2005; Xu 2010	
Mobility at 12 months Number of participants with independent mobility	Analysis 1.20	9	Adams 2001; Ekstrom 2007; Goldhagen 1994; Haynes 1996; Kuwabara 1998; Leung 1992; Tao 2013; Varela-Egocheaga 2009; Zehir 2015	Ekstrom 2007; Goldhagen 1994; Haynes 1996; Leung 1992; Tao 2013; Varela-Egocheaga 2009 (Appendix 4)
Mobility at 12 months	Analysis 1.21	2	Matre 2013; Sanders 2017	

(Continued) Number of participants able to complete a TUG				
Mobility at 12 months Mean scores, change from baseline	Analysis 1.19	1	Barton 2010	
Mortality, early (≤ 4 months)	Analysis 1.25	30	Barton 2010; Bridle 1991; Chechik 2014; Dujardin 2001; Giraud 2005; Guyer 1991; Hardy 1998; Harrington 2002; Hoffman 1996; Hoffmann 1999; Kukla 1997; Little 2008; Matre 2013; Michos 2001; Miedel 2005; O'Brien 1995; Ovesen 2006; Pahlpatz 1993; Pajarinen 2005; Papasimos 2005; Parker 2017; Radford 1993; Sadowski 2002; Sanders 2017; Saudan 2002; Utrilla 2005; Verettas 2010; Xu 2010; Zehir 2015; Zhou 2012	-
Mortality at 12 months	Analysis 1.26	46	Adams 2001; Ahrengart 1994; Aktselis 2014; Andalib 2020; Barton 2010; Baumgaertner 1998; Butt 1995; Cai 2016; Carulli 2017; Chechik 2014; Davis 1988; Eceviz 2020; Ekstrom 2007; Giraud 2005; Goldhagen 1994; Guerra 2014; Guyer 1991; Hardy 1998; Haynes 1996; Hoffman 1996; Hoffmann 1999; Kouvidis 2012; Kukla 1997; Leung 1992; Little 2008; Lopez 2002; Matre 2013; Michos 2001; Miedel 2005; Ovesen 2006; Pajarinen 2005; Parker 2017; Raimondo 2012; Radford 1993; Rahme 2007; Reindl 2015; Sadowski 2002; Sanders 2017; Saudan 2002; Sharma 2018; Singh 2017; Singh 2019; Tao 2013; Utrilla 2005; Xu 2010; Zehir 2015; Zhou 2012	-
Unplanned return to theatre	Analysis 1.27	50	Adams 2001; Ahrengart 1994; Aktselis 2014; Andalib 2020; Barton 2010; Benum 1994; Butt 1995; Carulli 2017; Chechik 2014; Davis 1988; Eceviz 2020; Ekstrom 2007; Giraud 2005; Goldhagen 1994; Guyer 1991; Haq 2014; Hardy 1998; Haynes 1996; Hoffman 1996; Hoffmann 1999; Kouvidis 2012; Kukla 1997; Leung 1992; Little 2008; Lopez 2002; Matre 2013; Michos 2001; Miedel 2005; Mott 1993; O'Brien 1995; Ovesen 2006; Pajarinen 2005; Papasimos 2005; Parker 2017; Pelet 2001; Radford 1993; Rahme 2007; Reindl 2015; Sadowski 2002; Sanders 2017; Saudan 2002; Sharma 2018; Singh 2017; Singh 2019; Utrilla 2005; Xu 2010; Zehir 2015; Zhou 2012; Zou 2009	-

Appendix 4. Scales used in 'critical outcomes'

Outcome	Scale	Range	Direction of effect

(Continued)

ADL	Barthel Index – ADL (Wade 1988)	0 to 100	Higher score indicates greater independence
	Functional Independence Measure (FIM) (Keitll 1987)	0 to 120	Higher score indicates better performance
	Japanese Orthopaedic Association (Marsh 2007)	0 to 20	Higher score indicates better performance
	Jensen (Jensen 1984)	1 to 4	Higher score indicates greater dependency
	Katz ADL (Katz 1963)	A to G	A: independence in all six functions B: independence in all but one of the six functions C–G: dependence in bathing and at least one more function
	Lower Extremity Measure (LEM) (Jaglal 2000)	0 to 100	Higher score indicates better performance
	Social dependency scale (Bowers 2016)	1 to 8	Higher score indicates greater dependency
Functional status	D'Aubigne (D'Aubigne 1954)	0 to 6	Higher score indicates better function
	Functional recovery score (Zuckerman 2000)	0 to 100 or 0 to 44	Higher score indicates better function
	Harris Hip Score (Singh 2016)	0 to 100	Higher score indicates better function
	Oxford Hip Score (Dawson 1996)	0 to 48	Higher score indicates better function
	Sanders post-trauma hip function assessing system (Cankaya 2016)	55-60: excellent 45-54: good 35-44: poor <34: fail	Higher score indicates better function
	Salvati and Wilson (Salvati 1973)	Excellent (≥ 32) Good (24 – 31) Fair (16 – 23) Poor (≤ 15)	Higher score indicates better function
HRQoL	EQ-5D (EuroQol 1990)	-0.654 (worst quality of life)	Higher score indicates better quality of life

(Continued)

		0 (dead) 1 (best quality of life)	
	SF-12 (Mols 2009)	0 to 100	Higher score indicates better quality of life
Mobility	Parker scale (Parker 1993)	0 to 9	Higher score indicates better mobility
	Timed Up and Go test (TUG) (Podsiadlo 1991)	To stand from a seated position and walk 6 steps	Lower time indicates better mobility

Footnotes

ADL: activities of daily living; **EQ-5D:** EuroQoL 5 Dimensions instrument; **SF-12:** short-form 12

Appendix 5. Categorical outcome data: complete data for all categories

Outcome	Study ID	Intramedullary: n/N	Extramedullary: n/N	Effect estimate (as reported by study authors)
ADL, early (≤ 4 months) Follow-up: 3 months	Pahlpatz 1993	Change in independence Same level: 28/48 Reduced by 1 level: 13/48 Reduced by 2 levels: 6/48 Reduced by 3 levels: 1/48	Change in independence Same level: 22/45 Reduced by 1 level: 16/45 Reduced by 2 levels: 7/45 Reduced by 3 levels: 0/45	Not reported
ADL at 12 months Follow-up: 6 months	Pahlpatz 1993	Change in independence Same level: 34/45 Reduced by 1 level: 7/45 Reduced by 2 levels: 3/45 Reduced by 3 levels: 1/45	Change in independence Same level: 32/43 Reduced by 1 level: 8/43 Reduced by 2 levels: 3/43 Reduced by 3 levels: 0/43	Not reported
Functional status at 12 months	Xu 2018	Excellent: 45/50 Good: 2/50 Fair: 2/50 Poor: 1/50	Excellent: 38/50 Good: 6/50 Fair: 3/50 Poor: 3/50	$P < 0.05$
Functional status at 12 months	Zou 2009	Salvati and Wilson score Excellent (≥32): 38/58 Good (24-31): 13/58	Salvati and Wilson score Excellent (≥32): 36/63 Good (24-31): 22/63	Not reported

(Continued)

		Fair (16-23): 7/58 Poor (≤15): 0/58	Fair (16-23): 3/63 Poor (≤15): 2/63	
Mobility, early (≦ 4 months)	Ekstrom 2007	Reported at 4 months; n = 75 Without aid/1 crutch: 35% 2 crutches/Zimmer frame: 53% 2 human support: 5% Unable/refused: 7%	Reported at 4 months; n = 71 Without aid/1 crutch: 25% 2 crutches/Zimmer frame: 62% 2 human support: 3% Unable/refused: 10%	Not reported
Mobility, early (≦ 4 months)	Guyer 1991	Reported at 3 months Full walking ability: 4/28 Less than one stick: 11/28 More than one stick: 13/28	Reported at 3 months Full walking ability: 6/32 Less than one stick: 16/32 More than one stick: 8/32	Not reported
Mobility, early (≦ 4 months)	Hoffmann 1999	Reported at 3 to 4 months Full walking ability: 13/45 Less than one stick: 16/45 More than one stick: 16/45	Reported at 3 to 4 months Full walking ability: 9/43 Less than one stick: 15/43 More than one stick: 19/43	Not reported
Mobility, early (≦ 4 months)	Ovesen 2006	Reported at 4 months Sticks, crutches or no walking aid: 37/73 Walking frame or wheelchair: 30/73 Missing or deceased: 6/73	Reported at 4 months Sticks, crutches or no walking aid: 43/73 Walking frame or wheelchair: 23/73 Missing or deceased: 7/73	P = 0.14
Mobility, early (≦ 4 months)	Pajarinen 2005	Reported at 4 months No aids needed: In need of aids, but independent: In need of assistance:	Reported at 4 months No aids needed: In need of aids, but independent: In need of assistance:	P values: No aids needed: 0.641 In need of aids, but independent: 0.827 In need of assistance: 0.194
Mobility, early (≦ 4 months)	Park 1998	Reported at 3 months; Confined to bed or wheelchair: 0 Support by another individual: 1 Walking frame: 2 Rollator: 0 Quadriped: 3 Stick: 8	Reported at 3 months Confined to bed or wheelchair: 1 Support by another individual: 2 Walking frame: 1 Rollator: 1 Quadriped: 4 Stick: 7	P > 0.05

(Continued)

		No support: 16	No support: 14	
Mobility at 12 months	Ekstrom 2007	Reported at 12 months; n = 64 Without aid/1 crutch: 41% 2 crutches/Zimmer frame: 50% 2 human support: 5% Unable/refused: 4%	Reported at 12 months; n = 56 Without aid/1 crutch: 38% 2 crutches/Zimmer frame: 52% 2 human support: 2% Unable/refused: 8%	Not reported
Mobility at 12 months	Goldhagen 1994	Ambulatory status, reported at average of 6.4 months Community: 10/29 Community with aid: 10/29 Household: 9/29	Ambulatory status, reported at average of 6.4 months Community: 13/36 Community with aid: 16 /36 Household: 7/36	Not reported
Mobility at 12 months	Haynes 1996	Reported at 6 months Independent: 1/18 Aided: 14/18 Bedbound: 3/18	Reported at 6 months Independent: 1/23 Aided: 18/23 Bedbound: 4/23	Not reported
Mobility at 12 months	Kukla 1997	Reported comparison to baseline at 6 months Unchanged 62% Slightly poorer 29% Markedly poorer 8.9%	Reported comparison to baseline at 6 months Unchanged 61% Slightly poorer 32% Markedly poorer 6.8%	P = 0.10 N = 89
Mobility at 12 months	Leung 1992	Reported at 6 months Independent: 34/93 Aided: 47/93 Chair/bedbound: 12/93	Reported at 6 months Independent: 31/93 Aided:53/93 Chair/bedbound: 9/93	P > 0.05
Mobility at 12 months	Tao 2013	Independent walking: 37/45 Assisted walking: 6/45 Bedridden: 2/45	Independent walking: 34/42 Assisted walking: 7/42 Bedridden: 1/42	Not reported
Mobility at 12 months	Varela-Egocheaga 2009	No help: 9/38 Cane: 21/38 Walker: 8/38 No walk: 0/38	No help: 11/36 Cane: 15/36 Walker: 8/38 No walk: 2/36	Not reported
Discharge destination	Baumgaertner 1998	Home: 11/64 Short-term/rehab: 30/64	Home: 14/66 Short-term/rehab: 31/66	Not reported

(Continued)

		Long-term nursing: 23/64	Long-term nursing: 21/66	
Discharge destination	Chechik 2014	Own home: 20/29 Nursing home: 2/29 Institution: 4/29 Change of residence: 4/29	Own home: 19/31 Nursing home: 4/31 Institution: 3/31 Change of residence: 3/31	Not reported
Discharge destination	Miedel 2005	Home: 8/109 Orthopaedic rehabilitation: 88/109 Nursing home: 12/109 Died before discharge: 1/109	Home: 12/108 Orthopaedic rehabilitation: 81/108 Nursing home: 8/108 Died before discharge: 7/108	Not reported
Discharge destination	Pajarinen 2005	Own home: 6/54 Nursing home: 1/54 Rehabilitation hospital: 45/54	Own home: 4/54 Nursing home: 2/54 Rehabilitation hospital: 48/54	P values: Own home: 0.742 Nursing home: 1 Rehabilitation hospital: 0.579
Discharge destination	Pelet 2001	Home: 6/13 Rehabilitation centre: 7/13	Home: 3/13 Rehabilitation centre: 10/13	P = 0.09
Discharge destination	Sadowski 2002	Home: 2/20 Nursing home /rehabilitation hospital: 16/20 Died in hospital: 2/19	Home: 4/19 Nursing home /rehabilitation hospital: 15/19 Died in hospital: 0/19	Not reported
Discharge destination	Sanders 2017	Own home: 20/123 Residential care: 5/123 Long-term rehab: 33/123 Short-term rehab: 58/123 Missing data: 1/123	Own home: 20/126 Residential care: 2/126 Long-term rehab: 37/126 Short-term rehab: 60/126 Missing data: 7/126	P = 0.19
Discharge destination	Saudan 2002	Home: 22/100 Nursing home /rehabilitation hospital: 74/100	Home: 24/106 Nursing home /rehabilitation hospital: 78/106	Not reported
Discharge destination	Varela-Egocheaga 2009	Home: 21/40 Intermediate hospital: 18/40 Not reported: 1/40	Home: 23/40 Intermediate hospital: 16/40 Not reported 1/40	Not reported

ADL: activities of daily living

Appendix 6. Data not included in analysis

Outcome	Measurement tool	Interventions	Study ID	Data for Intervention 1	Data for Intervention 2	Additional information P value reported by study authors
Early ADL (≤ 4 months)	Barthel Index Follow-up: 3 months	1. Gamma nail 2. AMBI hip screw	Aktselis 2014	Mean (SD): 73.6 (22.2)	Mean (SD): 70.7 (19.4)	Number of participants not reported P = 0.56
Early Functional status (≤ 4 months)	HHS Follow-up: 3 months	1. Gamma nails 2. DHS	Adams 2001	Average: 62.9 n: 156	Average: 61.8 n: 152	No distrubution values No P values
Early functional status (≤ 4 months)	HHS Follow-up: 40 days	1. Nail 2. PCCP plate	Raimondo 2012	Mean (SD): 50 (10.5)	Mean (SD): 55.3 (11.2)	Number of participants not reported P < 0.05
Early Functional status (≤ 4 months)	HHS Follow-up: 3 months	1. PFN (ultra short) 2. DHS	Sharma 2018	Average: 47.6 n: 31	Average: 53.4 n: 29	No distribution values P < 0.01
Functional status (12 months)	HHS Follow-up: 12 months	1. Gamma nails 2. DHS	Adams 2001	Average: 69.1 n: 126	Average: 70.3 n: 121	No distrubution values No P values
Functional status (12 months)	HHS Follow-up: 6 months	1. PFN 2. DHS	Calderon 2013	Mean: 89.3 n: unknown	Mean: 88.2 n: unknown	No distrubution values No P values
Functional status (12 months)	Salvati & Wilson (0 to 40, with 40 indicating greatest function) Follow-up: 12 months	1 Gamma nail 2. Proximal femoral nail 3. AMBI hip screw	Papasimos 2005	Gamma nail, mean: 33 PFN, mean: 30	Mean: 27	No distrubution values Number of participants was not specified No P values
Functional status (12 months)	HHS Follow-up: 12 months	1. Nail 2. PCCP plate	Raimondo 2012	Mean (SD): 68 (9.2)	Mean (SD): 72.1 (10.8)	Number of participants not reported P > 0.05
Functional status (12 months)	HHS Follow-up: 24 months	1. PFN (ultra short) 2. DHS	Sharma 2018	Average: 94.0 n: 31	Average: 94.2 n: 29	No distribution values P = 0.79

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Late Functional status (>24 months)	HHS; at 26 months	1. PFNA 2. LISS	Zhou 2012	Mean (range): 84.09 (61 to 100)	Mean (range): 86.04 (34 to 100)	Number of participants was not specified P = 0.247
HRQoL (≤ 4 months)	EQ-5D Follow-up: 3 months	1. Gamma nail 2. AMBI hip screw	Aktselis 2014	Mean (SD): 0.76 (0.21)	Mean (SD): 0.72 (0.24)	Number of participants not reported P = 0.438
Early mobility (≤ 4 months)	Mobility score (0 to 9); Parker 1993 Follow-up: 3 months	1. Gamma nail 2. AMBI hip screw	Aktselis 2014	Mean (SD): 4.6 (2.1)	Mean (SD): 3.8 (1.9)	Number of participants not reported for this time point. P = 0.095
Early mobility (≤ 4 months)	Mobility score (0 to 9); Parker 1993 Follow-up: 6 weeks	1. Intramedullary nail 2. SHS	Eceviz 2020	Mean: 7.1	Mean: 6.0	Distribution values not reported Not clear if data reported for all participants P values not reported
Length of hospital stay	-	1. Gamma nails 2. DHS	Bridle 1991	Average: 39 days n: 49	Average: 37 days n: 51	No distribution values No P value
Length of hospital stay	-	1. Gamma nails 2. DHS	Butt 1995	Mean: 22 (12 to 31) days n: 47	Mean: 23 (10 to 28) days n: 48	Type of distribution value is not reported No P value
Length of hospital stay	-	1. Kuntscher-Y nail 2. SHS	Davis 1988	Reported separately according to pre-fracture walking ability 1+2, mean: 4.2 weeks 3+4, mean: 4.0 weeks 5+6, mean: 3.6 weeks	Reported separately according to pre-fracture walking ability 1+2, mean: 3.0 weeks 3+4, mean: 4.4 weeks 5+6, mean: 4.7 weeks	No distribution values No P value
Length of hospital stay	-	1. Mini-invasive static nail 2. DHS	Dujardin 2001	Mean: 10 days n: 30	Mean: 10 days n: 30	No distribution values No P value
Length of hospital stay	-	1. Gamma nail 2. CHS	Goldhagen 1994	Mean: 12.2 days n: 35	Mean: 11.8 days n: 40	No distribution values No P value

(Continued)

Length of hospital stay	-	1. Gamma nail 2. DHS	Haynes 1996	Mean: 18.7 n: 19	Mean: 17.7 n: 31	No distribution values No P value
Length of hospital stay	-	1. Gamma nail 2. DHS	Lopez 2002	Mean: 11.1 days n: 43	Mean: 12.2 days n: 60	P = 0.071
Length of hospital stay	-	1. Gamma nail 2. Medoff sliding plate	Miedel 2005	Mean: 6 days n: 109	Mean: 6 days n: 108	No distribution values No P value
Length of hospital stay	-	1. Gamma nail 2. Sliding screw	Michos 2001	Average: 12 days n: 26	Average: 14.5 days n: 26	No distribution values No P value
Length of hospital stay	-	1. Gamma nail 2. DHS	O'Brien 1995	Median (range): 16 (3 to 92) n: 52	Median (range): 18 (4 to 108) n: 49	No P value
Length of hospital stay	-	1. PFN 2. Gamma Nail 3. AMBI hip screw	Papasimos 2005	1. Average: 8.8 days 2. Average: 8.6 days	Average: 9.9 days	P > 0.05
Length of hospital stay	-	1. Gamma nail 2. Angled blade plate	Pelet 2001	Average: 24.3 days n: 13	Average: 38.9 days n: 13	P < 0.05
Length of hospital stay	-	1. Nail 2. Blade plate	Rahme 2007	Mean: 25 days n: 29	Mean: 22 days n: 29	P = 0.7
Length of hospital stay	-	1. TRIGEN INTERTAN 2. SHS	Sanders 2017	Median (range): 12 (1 to 147) days n: 123	Median (range): 10 (2.8 to 102) days n: 126	P = 0.21
Length of hospital stay	-	1. PFN (ultra short) 2. DHS	Sharma 2018	Mean: 9.29 n: 31	Mean: 10.1 N: 29	P = 0.13
Length of hospital stay	-	1 Gamma nail 2. DHS	Verettas 2010	Mean 10.2 days Range: 10 to 14	Mean: 10.3 days Range: 10 to 15	No distribution values P = 0.144
Length of hospital stay	-	1. Gamma nail 2. PCCP	Varela-Egocheaga 2009	Mean: 12.8 days n: 40	Mean: 11.77 days n: 40	No distribution values No P value

(Continued)

Length of hospital stay	-	1. PFNA 2. LISS	Zhou 2012	Mean (range): 10.33 (5 to 13) days n: 36	Mean (range): 7.61 (5 to 14) days n: 28	P = 0.457
Early pain, early (≤ 4 months)	Pain at rest Follow-up: 4 months	1. PFN 2. Medoff sliding plate	Ekstrom 2007	Median: 0	Median: 0	No distrubution values P = 0.88
Early pain, early (≤ 4 months)	Pain, Charnley scale Follow-up: 4 months	1. Gamma Nail 2. Medoff sliding plate	Miedel 2005	Mean: 4.8 n: 87	Mean: 4.7 n: 81	No distrubution values No P values
Early pain, early (≤ 4 months)	VAS score; 6 to 10 days	1. Gamma nail 2. DHS	Verettas 2010	Mean (range): 2.7 (0 to 7) n: 59	Mean (range): 2.8 (0 to 8) n: 59	P = 0.747
Pain at 12 months	Pain at rest Follow-up: 12 months	1. PFN 2. Medoff sliding plate	Ekstrom 2007	Median: 0	Median: 0	No distrubution values No P values
Pain at 12 months	Pain, Charnley scale Follow-up: 12 months	1. Gamma Nail 2. Medoff sliding plate	Miedel 2005	Mean: 5.3 n: 82	Mean: 5.2 n: 74	No distribution values No P values

ADL: activities of daily living; DHS: dynamic hip screw; HHS: Harris Hip Score; HRQoL: health-related quality of life; LISS: Less Invasive Stabilization System; PCCP: percutaneous compression plate; PFN: proximal femoral nail; SHS: sliding hip screw

Appendix 7. Subgroup analyses

Here we present a summary of subgroup analyses conducted for outcomes which included at least 10 studies

Subgroup analysis according to length of cephalomedullary nails: short nails; long nails; mixed or unknown length of nails	
Functional status (12 months)	This analysis only included studies of short nails and studies in which the nail length was unknown. The test for subgroup interactions showed no evidence of a difference between short nails and those with unknown lengths. We noted, however, that statistical heterogeneity was substantial between those studies in which nail length was unknown; for short nails I^2 was 40% (Analysis 2.1).
Mobility (12 months; mean scores)	Although the test of subgroup interactions showed a difference between short and long nails (P < 0.0001), the analysis included only one small study using long nails and we were therefore not confident that this subgroup effect was meaningful (Analysis 2.2).
Mobility (12 months; independent mobility)	This analysis only included studies of short nails and nails of mixed or unknown lengths. The test for subgroup interactions showed no evidence of a difference between these groups (Analysis 2.3).

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Early mortality	We noted no difference between subgroups of short nails versus mixed or unknown nail lengths. Although the test of subgroup interactions showed a difference between short and long nails (P = 0.04), the analysis included only two small studies using long nails, and we were therefore not confident that this subgroup effect was meaningful (Analysis 2.4).
Mortality (12 months)	Subgroup analysis included studies of short nails, long nails, and mixed or unknown nail lengths. We noted no difference between any of these subgroups (Analysis 2.5).
Unplanned return to theatre	Subgroup analysis included studies of short nails, long nails, and mixed or unknown nail lengths. We noted no difference between any of these subgroups (Analysis 2.6).
Subgroup analysis according to fracture instability: stable fractures; unstable fractures; mixed or unknown fracture stability[a]	
Functional status (12 months)	Most studies included both stable and unstable fractures. Four studies included only unstable fractures (Adeel 2020; Haq 2014; Singh 2017), and two studied included only stable fractures (Cai 2016; Eceviz 2020). We noted that statistical heterogeneity in the unstable group was lower (I^2 = 33%) than the mixed group (I^2 = 97%). Overall, we noted no evidence of subgroup differences from formal testing of subgroup interactions (Analysis 3.1).
Mobility (12 months; mean scores)	This outcome included no studies of stable fractures. We noted no evidence of subgroup differences from formal testing of subgroup interactions between studies of unstable fractures and studies with a mixed fracture stability population (Analysis 3.2).
Mobility (12 months; independent mobility)	This outcome included no studies of stable fractures. We noted no evidence of subgroup differences from formal testing of subgroup interactions between studies of unstable fractures and studies with a mixed fracture stability population (Analysis 3.3) .
Early mortality	This outcome included no studies of stable fractures. We noted no evidence of subgroup differences from formal testing of subgroup interactions between studies of unstable fractures and studies with a mixed fracture stability population (Analysis 3.4); we included one study in the 'mixed' subgroup in which fracture stability was not reported (Michos 2001).
Mortality (12 months)	Most studies included both stable and unstable fractures; we included one study in the 'mixed' subgroup in which fracture stability was not reported (Raimondo 2012). Ten studies included unstable fractures (Aktselis 2014; Andalib 2020; Barton 2010; Ekstrom 2007; Harrington 2002; Miedel 2005; Reindl 2015; Sadowski 2002; Xu 2010; Zehir 2015), and three studies included stable fractures (Cai 2016; Eceviz 2020; Sharma 2018). We noted no evidence of subgroup differences from formal testing of subgroup interactions (Analysis 3.5).
Unplanned return to theatre	Most studies included both stable and unstable fractures; we included one study in the 'mixed' subgroup in which fracture stability was not reported (Michos 2001). Twelve studies included unstable fractures (Aktselis 2014; Andalib 2020; Barton 2010; Ekstrom 2007; Haq 2014; Miedel 2005; Papasimos 2005; Reindl 2015; Sadowski 2002; Singh 2017; Xu 2010; Zehir 2015), and two studies included stable fractures (Eceviz 2020; Sharma 2018). We noted no evidence of subgroup differences from formal testing of subgroup interactions (Analysis 3.6).
Periprosthetic fractures according to date of study publication: earlier than 2010; from 2010 onwards	
Intraoperative periprosthetic fractures	The test of subgroup interactions demonstrated no differences between studies published before 2010 and studies published from 2010 onwards (P = 0.46). Studies often reported no intraoperative fractures; of the eight studies published from 2010 onwards, only three had event data (Aktselis 2014; Verettas 2010; Xu 2010). See Analysis 4.1.
Postoperative periprosthetic fractures	Visual inspection of the forest plot, ordered by year of reporting, does not reveal a trend in the direction or size of the risk ratio. We noted fewer postoperative fractures in the cephalomedullary group in studies published from 2010 onwards, but the test for subgroup interactions demonstrat-

(Continued)

	ed no difference between events according to time of study publication (Analysis 4.2; Figure 9). Again, event data were sparse and some studies contributing to this evidence reported no events in either group.

[a] We did not include Rahme 2007 in the subgroup analysis; this study exclusively included subtrochanteric fractures

Appendix 8. Sensitivity analyses

Here, we report a summary of the senstivity analyses for outcomes for which our interpretation of the effect estimate was altered (or when the direction of effect changed, but our interpretation remained the same), or when statistical heterogeneity was reduced such that pooling of data was appropriate. No data are presented for sensitivity analyses related to performance bias (because the surgeons did not have comparable experience with both types of study implants) or studies that used an extramedullary device; these sensitivity analyses did not alter our interpretation of the effect estimates.

Sensitivity analysis: studies at high or unclear risks of selection bias for sequence generation	
ADL (12 months)	We excluded Aktselis 2014 from Analysis 1.4. Although the estimate now favoured the alternative implant (extramedullary implants), the difference in effect was small and did not alter our interpretation of these data, which continued to indicate little or no difference between implants.
Functional status (≤ 4 months, mean scores)	Only one of the two studies in Analysis 1.8 was at low risk of selection bias. Although this study favoured the alternative implant (extramedullary implants), the estimate was imprecise and we did not alter our interpretation of these data, which continued to indicate little or no difference between implants.
Mobility (≤ 4 months, independent mobility)	We excluded four studies that had high or unclear risks of selection bias from Analysis 1.13 (Carulli 2017; Guyer 1991; Hoffmann 1999; Park 1998). Although the estimate still favoured cephalomedullary implants, we found that the estimate now indicated little or no difference between the implants (RR 1.07, 95% CI 0.87 to 1.32; 3 studies, 375 participants; I^2 = 43%).
Mobility (12 months, mean scores)	Half of the studies in Analysis 1.18 were at high or unclear risks of bias (Aktselis 2014; Gou 2013; Han 2012; Hardy 1998; Singh 2017; Utrilla 2005). Although the estimate still favoured cephalomedullary implants, we found that the estimate now indicated little or no difference between the implants when only these studies were included in analysis (RR 0.70, 95% CI -0.13 to 1.52; 6 studies, 525 participants; I^2 = 73%).
Mortality (12 months)	Only 21 studies were at low risk of selection bias in Analysis 1.26 (Andalib 2020; Barton 2010; Cai 2016; Chechik 2014; Davis 1988; Eceviz 2020; Ekstrom 2007; Guerra 2014; Hoffman 1996; Little 2008; Matre 2013; Ovesen 2006; Pelet 2001; Reindl 2015; Sadowski 2002; Sanders 2017; Saudan 2002; Singh 2019; Tao 2013; Xu 2010; Zhou 2012). Although the estimate favoured the alternative implant (extramedullary implants) when we included only these studies, the difference in effect was small and we did not alter our interpretation of these data, which continued to indicate little or no difference between implants.
Sensitivity analysis: studies at high risk of attrition bias[a]	
ADL (≤ 4 months)	We excluded Sanders 2017 from Analysis 1.1. Although statistical heterogeneity remained high, analysis without these studies included less statistical heterogeneity. The estimate indicated little or no difference between implants (SMD 0.23, 95% CI -0.31 to 0.77; 3 studies, 292 participants; I^2 = 73%).
Mobility (≤ 4 months)	We excluded three studies from Analysis 1.13 (Ekstrom 2007; Guyer 1991; Pajarinen 2005). Without these studies, we noted that the estimate now indicated little or no difference between implants (RR 1.07, 95% CI 0.90 to 1.28; 4 studies, 430 participants; I^2 = 41%).

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Mobility (12 months, able to complete TUG)	We excluded Matre 2013 from Analysis 1.21. Only one study remained, and the estimate for this study indicated an improvement in mobility with cephalomedullary implants (RR 1.22, 95% CI 1.01 to 1.46; 1 study, 249 participants).

[a]We removed studies from analysis for the specific outcomes that we judged could be influenced by this attrition.

WHAT'S NEW

Date	Event	Description
19 May 2021	New citation required and conclusions have changed	Title: we edited the title to reflect current terminology for cephalomedullary nails, and to reflect a change to including only older adults. Review authors: we added four new review authors (JG, XG, SL, and RM), and removed one review author (HH). Methods: we updated review methods to reflect current methodological expectations, and altered the outcomes for consistency with other reviews in this series (as part of a Cochrane Programme Grant). Searches and data extraction: we updated and re-ran the searches for studies, extracted data on new studies, conducted risk of bias assessments on all included studies, and incorporated new data into the review. Results: this review update includes an additional 33 studies. Conclusions: changes were made to the conclusions to reflect findings from critical outcomes and other outcomes for which we found effect estimates which favoured one or other treatment.

HISTORY

Protocol first published: Issue 2, 1995
Review first published: Issue 3, 1996

Date	Event	Description
6 November 2019	New citation required and conclusions have changed	Title changed to remove reference to Gamma nails. Previous title: Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults Parker 2010
3 August 2010	New search has been performed	For the seventh substantive update, which first appeared in Issue 9, 2010, the main changes were as follows. 1. The search for trials was updated to April 2010. 2. Risk of bias was assessed for sequence generation, allocation concealment and surgeons' experience with the devices. 3. There were seven newly included trials (Barton 2010; Lee 2007; Little 2008; Rahme 2007; Vareal-Egocheaga 2009; Verettas 2010; Zou 2009). Little 2008 was formerly Fernando 2006 in 'Studies awaiting classification' and Rahme 2007 was formerly Harris 2005 in 'Studies awaiting classification'. 4. Extra reference for a conference abstract for Giraud 2005 added.

Date	Event	Description
		5. Six new comparisons were added (Proximal femoral nail antirotation versus SHS; Long Gamma nail versus SHS; Holland nail versus SHS; Gamma nail versus the percutaneous compression plate (PCCP); Intramedullary nail (two types) versus the SHS; femoral nails versus condylar screw or blade plates for subtrochanteric fractures). 6. One newly identified study (Rafiq 2009) was added to 'Studies awaiting classification'. 7. Nine newly identified studies (Cao 2009; Hu 2006; Liu 2008; Nouisri 2006; Pan 2009; Saarenpaa 2009; Zhang 2009; Zhao 2009; Ziran 2009) were excluded. 8. Four more ongoing studies identified and added to ongoing studies (Matre 2009; Molnar; REGAIN; Schipper). 9. All studies presented with the analysis were ordered chronologically to clarify if changes were occurring over time. 10. The Discussion was restructured and revised. 11. Changes were made to the conclusions.
2 August 2010	New citation required and conclusions have changed	Changes were made to the conclusions reflecting the inclusion of further comparisons.
1 April 2008	New search has been performed	Converted to new review format.
4 March 2008	New citation required and conclusions have changed	For the sixth substantive update, which first appeared in Issue 3, 2008, the main changes were as follows. 1. The search for trials was updated to June 2007. 2. Four newly identified studies (Ekstrom 2007; Giraud 2005; Ovesen 2006; Papasimos 2005) were included. 3. One new comparison was added (Targon PF nail versus SHS) and one category extended to include the PFN versus Medoff plate comparison. 4. One previously ongoing study (Khaleel) was moved to awaiting assessment and renamed Fernando 2006. 5. One newly identified study (Harris 2005) was added to awaiting assessment. 6. Five newly identified studies (Azzoni 2004; Bienkowski 2006; Kafer 2005; Klinger 2005; Tarantino 2005) were excluded. 7. Additional information and data for an already included trial were added (Mehdi 2000). 8. The 'Synopsis' was rewritten as a 'Plain language summary'; and other changes made to comply with format and methodological requirements. 9. There were no substantial changes made to the conclusions.
15 August 2005	New search has been performed	For the fifth substantive update, which first appeared in Issue 4, 2005, the main changes were as follows. 1. The search for trials was updated to June 2005. 2. The newly identified studies of Miedel 2005, Pajarinen 2005 and Utrilla 2005 were included. 3. Study of Mott 1993 moved from excluded to included on receipt of additional information. 4. Three newly identified studies (Bhatti 2004; Khan 2002; Schipper 2004) were excluded. 5. One newly identified study (Khaleel) is listed as an ongoing trial and two other studies (Ahmad; White) await assessment. 6. The length of the 'Abstract' was reduced and other format changes undertaken to comply with the Cochrane Style Guide (November 2004). Other changes, such as the consideration of

Date	Event	Description
		the I-squared statistic were made to comply with the Cochrane Handbook for Systematic Reviews of Interventions (March 2005). 7. Graphical presentation of the results was revised and compressed to reduce the number of graphs. 8. There were no substantial changes made to the conclusions.
1 November 2003	New search has been performed	For the fourth substantive update, which first appeared in Issue 1, 2004, the main changes were as follows. 1. The update of the search for trials to May 2003. 2. Newly identified study of Marques Lopez 2002 included. 3. Though a further report of Ahrengart 1994 was identified giving results for more patients we kept the results from the previous report, pending clarification. 4. Three newly identified studies (Hardy 2003; Herrera 2002; Nuber 2003) were excluded. 5. The studies of Davidson 1996 and Prinz 1996 were moved from 'Awaiting assessment' to excluded. 6. Study of Moran 2000 moved from ongoing to excluded. 7. Reference to letter on study of Hardy 1998 added. 8. Details of newly identified ongoing study (Parker) added.
1 August 2002	New search has been performed	For the third substantive update, which first appeared in Issue 4, 2002, the main changes were as follows. 1. The update of the search for trials to August 2002. 2. Inclusion of newly identified study (Pelet 2001) comparing the Gamma nail with a blade plate. 3. Exclusion of another newly identified study (Dicicco 2000). 4. Incorporation of further details and results of three already included trials (Harrington 2002; Sadowski 2002; Saudan 2002), previously Harrington 1999, Saudan 2001b and Saudan 2001a respectively, obtained from newly published full reports of these trials. 5. Some restructuring of the text and tables to give emphasis on overall results of short femoral nails and lessen the emphasis on the outdated Kuntscher-Y nail. 6. Some adjustments to the 'Conclusions' but no substantive changes in implications.
1 November 2001	New search has been performed	For the second substantive update, which first appeared in Issue 1, 2002, the main changes were as follows. 1. The update of the search for trials to August 2001. 2. The inclusion of three new Gamma nail trials (Adams 2001; Kuwabara 1998; Michos 2001) and three new intermedullary hip screw trials (Harrington 1999; Hoffmann 1999; Mehdi 2000). 3. Two Gamma nail studies (Hogh 1992; Mott 1993) previously in studies awaiting assessment are now excluded as no further information has been forthcoming. 4. The inclusion of two new comparisons, each represented by one study: proximal femoral nail versus the sliding hip screw (Saudan 2001a) and proximal femoral nail versus the dynamic condylar screw (Saudan 2001b). 5. The inclusion of one trial on a mini-invasive nail (Dujardin 2001). 6. Peto odds ratios changed to relative risks in accordance with Cochrane Review Group requirements. 7. The addition of a new outcome, 'All technical complications of fixation' and the clarification of the outcome: 'operative fracture'.

Date	Event	Description
		8. Pooling of the results for key outcomes for three of the short proximal femoral nails (Gamma, IMHS and the PFN) versus the sliding hip screw. 9. Addition of a 'Synopsis'.
1 February 1999	Amended	The first substantive update, appearing in Issue 2, 1999, involved an expansion of the original review, "Gamma nail versus sliding hip screw for extracapsular hip fractures", to include other cephalocondylic nails. Four more studies on the Gamma nail (Haynes 1996; Kukla 1997; Pahlpatz 1993; Park 1998), and two studies on the intramedullary hip screw (Baumgaertner 1998; Hardy 1998) were included.

CONTRIBUTIONS OF AUTHORS

SL (systematic reviewer) screened and identified included studies, extracted study data, interpreted the findings, and drafted the review.

RM (systematic reviewer) screened and identified included studies, extracted study data, interpreted the findings, and drafted the review.

JG (content expert, trauma and orthopaedics) screened and identified included studies, extracted study data, interpreted the findings, reviewed and approved the final review.

MP (content expert, trauma and orthopaedics) interpreted the findings and reviewed and approved the final review. In previous versions of the review, MP also screened and identified included studies, extracted study data, interpreted the findings, and drafted the review.

XG (guarantor and content expert, trauma and orthopaedics) screened and identified included studies, interpreted the findings, reviewed and approved the final review, and is the guarantor of the content.

Editorial contributions

Liz Bickerdike (Acute and Emergency Care Network Associate Editor) advised on methodology and review content.

Mike Brown (Acute and Emergency Care Network Senior Editor) approved the final version for publication.

Maria Clarke (Information Specialist) ran 'top-up' literature searches and edited the 'Search methods' section.

Kerry Dwan (Statistical Editor): advised on methodology and review content.

Joanne Elliott (Managing Editor): co-ordinated the editorial process and edited the review.

Jessica Sharp (Copy Editor): copy-edited the review.

Xavier Griffin and Sharon Lewis are members of the editorial base but were not involved in the editorial process or decision making for this review.

DECLARATIONS OF INTEREST

SL has no known conflicts of interest.

RM has no known conflicts of interest.

JG has no known conflicts of interest.

MP has received and may continue to receive financial payment from manufacturing companies of orthopaedic implants, for attending meetings organised by these companies and for advising on the design and use of hip fracture implants. He has remained independent of study selection decisions, risk of bias assessments, and data extraction of any of the studies on which he is an author, co-applicant or has had an advisory role.

XG is funded by a National Institute for Health Research Clinician Scientist Grant. Further funding from industry and charitable grants are and have been made available to his institution. All decisions relating to the design, conduct, analysis, write-up, and publication of research are independent of these funders. He has ongoing expert consultancy with several companies; none involve the development

of any implant for use in hip fracture care. He has remained independent of study selection decisions, risk of bias assessments, and data extraction of any of the studies on which he is an author, co-applicant, or has had an advisory role.

SOURCES OF SUPPORT

Internal sources

- No sources of support provided

External sources

- NIHR Systematic Review Programme Grant 16/114/15, UK

  A programme of high priority reviews for the management of patients with hip fracture: a collaboration which can inform future healthcare policy guidance
- NIHR Cochrane Infrastructure funding, UK

  Awarded to the Cochrane Bone, Joint and Muscle Trauma Group

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We note here the differences between the review update and the previous published version of the review (Parker 2010). The changes to the 'Methods' section largely reflect the changes to Cochrane methodology since 2010 (Methodological Expectations in Cochrane Intervention Reviews), and responses to guidance resulting form the prioritisation process underpinning the Cochrane Programme Grant on the management of hip fracture.

Review information

- We edited the title to reflect the variety of cephalomedullary nails now available, and to reflect the older population included in the review.
- Four new review authors joined the review team (JG, XG, SL, RM), and one review author left the review team (Helen Handoll).

Objectives

- We edited the objectives to reflect the older population included in the review, and to describe the nails as cephalomedullary nails. We removed the outcomes from this section; we changed the outcomes in the updated review (see below).

Methods

Criteria for considering studies for this review

- Types of studies: we clarified that conference abstracts were included if they reported sufficient information relating to the methods and outcomes of interest.
- Types of participants: we specified the inclusion of fractures from low-energy trauma. We included only older adults, which better reflected the expected population with hip fracture from low-energy trauma.
- Types of outcome measures: we restructured this section into critical outcomes for presentation in the summary of findings tables; other important outcomes; and adverse events related or unrelated to the implant or fracture, or both. The outcomes reported in this review resulted from consultation with stakeholders, including a formal consultation workshop in January 2018, consideration of the UK core outcome set for hip fracture trials (Haywood 2014), and the National Institute for Health and Care Excellence (NICE) clinical guideline, Hip fracture: management (CG124). Many of the outcomes collected in previous versions of the review are still reported. Some outcomes from previous versions of the review are no longer reported (operative blood loss, length of surgery, radiographic screening time, leg shortening, varus deformity, external rotation deformity); data for these outcomes are available in Parker 2010. Previously, the review focused on a one-year follow-up, which reflected that recovery from hip fracture can be a protracted process. However, there is increasing loss to follow-up over the first year after surgery, and some evidence of consistency between quality-of-life and 'poor outcome' (mortality or deterioration in residential status) at four months and 12 months (Griffin 2015). Hence, a key shift in our reporting is the greater focus on, and preference given to, interim outcomes at around four months for quality-of-life and function outcomes.

Search methods for identification of studies

- We searched a wider range of databases; these included databases used in previous versions of the review. The search strategy in this review was developed in consultation with Information Specialists and reflects a search criteria for a series of related hip fracture reviews.

Data collection and analysis

- Assessment of risk of bias in included studies: we used the Cochrane risk of bias tool (Higgins 2011). We used standard domains for assessment and added a domain to assess whether surgeons had equal experience with both types of devices used in the study.
- Dealing with missing data: we used decisions reached during the risk of bias assessment to evaluate attrition in the review by excluding studies in which data were not balanced between groups or attrition was high.
- Data synthesis: we used a random-effects model rather than a fixed-effect model in this review in order to account for the complexities in interventions. We used standardised mean difference (SMD) for continuous measures in which different measurement tools were used in the included studies.
- Subgroup analysis and investigation of heterogeneity: we did not subgroup data in this review according to the different manufacturers of cephalomedullary nails and extramedullary implants. We aimed to explore specific key modifiers (age, cognitive impairment, and functional status), but we did not find sufficient studies reporting data according to these modifiers. In this review, we used subgroup analysis to explore the length of cephalomedullary nails (long or short nails), and fracture instability (stable or unstable fractures). We added a posthoc subgroup analysis to explore a potential improvement in the design of cephalomedullary nails since 2010, specifically on the risk of intraoperative and postoperative periprosthetic fractures. We specified that subgroup analysis was only conducted when we had at least 10 studies in the primary analysis.
- Sensitivity analysis: as well as sensitivity analysis described previously, we also evaluated the impact of our findings of including studies of static designs of extramedullary implants.
- Summary of findings table and GRADE: we included a GRADE assessment of all the critical outcomes, and we presented a summary of findings table. We found that some adverse events clearly indicated an improvement or risk with one of the treatments, and because these adverse events were important clinical considerations, we used GRADE to assess the certainty of this evidence. We therefore assessed the certainty of the evidence for: intraoperative and postoperative periprosthetic fractures, superficial infections, and non-union.
- We also presented the methods we used in the sections 'Measures of treatment effects', 'Unit of analysis issues', and 'Assessment of reporting bias'. These methods were not previously presented in the review.

INDEX TERMS

Medical Subject Headings (MeSH)

Bone Nails; Fracture Fixation, Internal; *Fracture Fixation, Intramedullary [adverse effects]; *Hip Fractures [surgery]; Nails; Systematic Reviews as Topic

MeSH check words

Aged; Aged, 80 and over; Female; Humans; Middle Aged