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Extramedullary fixation implants and external fixators for extracapsular hip fractures in adults (Review)

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Extramedullary fixation implants and external fixators for extracapsular hip fractures in adults (Review)

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[Intervention Review]

Extramedullary fixation implants and external fixators for extracapsular hip fractures in adults

Martyn J Parker¹, Avishek Das¹¹Department of Orthopaedics, Peterborough and Stamford Hospitals NHS Foundation Trust, Peterborough, UK**Contact address:** Martyn J Parker, Department of Orthopaedics, Peterborough and Stamford Hospitals NHS Foundation Trust, Peterborough City Hospital, CBU PO Box 211, Bretton Gate, Peterborough, Cambridgeshire, PE3 9GZ, UK. martyn.parker@pbh-tr.nhs.uk.**Editorial group:** Cochrane Bone, Joint and Muscle Trauma Group**Publication status and date:** New search for studies and content updated (no change to conclusions), published in Issue 2, 2013.**Citation:** Parker MJ, Das A. Extramedullary fixation implants and external fixators for extracapsular hip fractures in adults. *Cochrane Database of Systematic Reviews* 2013, Issue 2. Art. No.: CD000339. DOI: [10.1002/14651858.CD000339.pub3](https://doi.org/10.1002/14651858.CD000339.pub3).

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ABSTRACT

Background

Extramedullary fixation of hip fractures involves the application of a plate and screws to the lateral side of the proximal femur. In external fixators, the stabilising component is held outside the thigh by pins or screws driven into the bone. This is an update of a Cochrane review first published in 1998, and last updated in 2005.

Objectives

To assess the relative effects of different types of extramedullary fixation implant, as well as external fixators, for treating extracapsular proximal femoral (hip) fractures in adults.

Search methods

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (July 2011), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2011, Issue 2), MEDLINE (1966 to June Week 4 2011), EMBASE (1988 to 2011 Week 25), various other databases, conference proceedings and reference lists.

Selection criteria

Randomised or quasi-randomised controlled trials comparing extramedullary implants or external fixators for fixing extracapsular hip fracture in adults were included.

Data collection and analysis

Two review authors independently selected trials, assessed risk of bias and extracted data. Data were pooled where appropriate.

Main results

The 18 included trials tested seven comparisons in a total of 2615 mainly female and older participants with a total of 2619 fractures. All trials had methodological flaws that may affect the validity of their results.

Three trials of 355 participants comparing a fixed nail plate (Jewett or McLaughlin) with the sliding hip screw (SHS) found an increased risk of fixation failure for fixed nail plates.

The two trials of 433 participants comparing the Resistance Augmented Bateaux (RAB) plate with the SHS had contrasting results, notably in terms of operative complications, fixation failure and anatomical restoration.

One trial of 100 participants comparing the Pugh nail and the SHS found no significant difference between implants.

Extramedullary fixation implants and external fixators for extracapsular hip fractures in adults (Review)

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Three trials of 458 participants compared the Medoff plate with the SHS. There was a trend to higher blood losses and longer operation times for the Medoff plate along with a trend to a lower risk of fixation failure with the Medoff plate for unstable trochanteric fractures.

Two trials of 676 participants compared the Medoff plate with three different screw-plate systems. There were no statistically significant differences in outcome for trochanteric fractures. For subtrochanteric fractures, there was a lower fixation failure rate for the Medoff plate but no evidence for differences in longer-term outcomes.

Four trials of 396 participants comparing the Gotfried percutaneous compression plate (PCCP) with a SHS found a trend to lower blood loss and transfusion requirements for the PCCP but no other confirmed differences in outcomes between implants. Three of the trials reported intra-operative problems with the PCCP, some of which precluded its use.

Three trials of 200 participants comparing external fixation with a SHS found less operative trauma for the external fixation. Final outcome appeared similar.

Authors' conclusions

The markedly increased fixation failure rate of fixed nail plates compared with the SHS is a major consideration and thus the SHS appears preferable.

There was insufficient evidence from other comparisons of extramedullary implants or on the use of external fixators to draw definite conclusions.

PLAIN LANGUAGE SUMMARY

Fixation devices secured across the fracture that are placed either directly or externally for treating hip fractures located outside the hip joint

Hip fractures located outside the hip joint capsule (extracapsular hip fractures) may be surgically fixed using metal implants. Often these are extramedullary devices consisting of a screw or rod, inserted in the upper part of the thigh bone (femur) to bridge (fix) the fracture, connected to a plate secured to the femur. Sometimes external fixators are used. In these, the stabilising component is held outside the thigh by pins or screws driven into the bone on either side of the fracture.

The 18 randomised controlled trials included in this review tested seven comparisons in a total of 2615 mainly female and older participants. All trials had methodological flaws that may affect the validity of their results and there was a general lack of evidence on long-term effects and functional recovery. Some extramedullary implants appeared to be associated with an increased risk of fixation complications and reoperation. In particular, three trials comparing a fixed nail plate (Jewett or McLaughlin) with the sliding hip screw (the 'standard' extramedullary device for these fractures) found an increased risk of fixation failure for fixed nail plates. Less invasive implants, such as the external fixator, which require smaller incisions resulted in less blood loss and often quicker operations than the sliding hip screw.

We concluded that the sliding hip screw seems preferable to older types of fixed nail plates given their high rate of implant and fixation failure. However, there was not enough evidence to draw conclusions for other comparisons of extramedullary implants or on the use of external fixators.

BACKGROUND

Description of the condition

Proximal femoral fractures, generally termed 'hip fractures', can be subdivided into intracapsular fractures (those occurring proximal to the attachment of the hip joint capsule to the femur) and extracapsular (those occurring distal to the hip joint capsule). Extracapsular fractures are those which traverse the femur within the area of bone bounded by the intertrochanteric line proximally up to a distance of five centimetres from the distal part of the lesser trochanter. Numerous subdivisions and classification methods exist for these fractures, and other terms that are used to describe these fractures include trochanteric, subtrochanteric, pertrochanteric, intertrochanteric, basal and lateral femoral fractures ([Parker 2002](#)).

The majority of these fractures occur in an older population with an average age of around 80 years. Females predominate over males by about four to one. The number of people sustaining a hip fracture continues to rise due to a combination of an increasingly elderly population and a continued increase in the age specific incidence in some countries. An estimated 1.26 million hip fractures occurred in adults in 1990 with predictions of numbers rising to 7.3 up to 21.3 million by the year 2050 ([Gulberg 1997](#)). Approximately half of these fractures are extracapsular.

Description of the intervention

Operative treatment was introduced in the 1950s using a variety of different implants. An extramedullary fixation implant refers to an implant, which has a nail, or screw, which is passed up the femoral neck to the femoral head. This is connected to a side plate, which is secured to the femur using screws. A variant is the external fixator, in which the stabilising component is held outside the thigh by pins or screws driven into the bone on either side of the fracture.

The sliding hip screw (SHS) is synonymous with the term compression hip screw and equivalent models such as the Dynamic, Richards or Ambi hip screws. It consists of a lag screw, passed up the femoral neck to the head, which 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. Currently the most prevalent implant for the surgical treatment of extracapsular fractures is the SHS and this is considered the standard treatment for extracapsular hip fractures by most orthopaedic surgeons.

Fixed nail plates (FNP) consist of a nail, which is passed up the femoral neck to the femoral head, connected to a plate on the femur. These implants have no capacity for sliding and hence are termed 'static' or 'fixed' implants. In some implants, such as the Jewett nail, the nail is fixed to the plate at manufacture. In others, such as the Thornton or McLaughlin nail plates, the nail is connected to the plate at the time of surgery with a locking bolt.

The Resistance Augmented Bateaux or Rigidity Augmentation Baixauli plate (RAB plate) is similar to a fixed nail plate of the Jewett type, but has an additional oblique strut to connect the nail and the side plate. This strut increases the strength of the implant and resists collapse occurring at the fracture site.

The Pugh nail ([Pugh 1955](#)) is similar to the SHS except that, instead of a lag screw being passed up the femoral neck, a nail with a trifin

or three-flanged terminus is inserted by a punching mechanism. This is then connected to the side plate in the same manner as for a SHS.

The Medoff plate ([Medoff 1991](#)) is a modification of the sliding hip screw, where a lag screw is again passed up the femoral neck and attached to a plate on the side of the femur. The difference is that the plate has 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. An additional variant of the Medoff plate is the capability of compressing the fracture distally using the two interlocking plates and a compression screw. In addition, 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. Case series reports of the Medoff plate have described technical details of the operation ([Lunsjo 1996](#); [Olsson 1997](#)).

The Gotfried percutaneous compression plate (PCCP) has a side plate that is inserted, via a small incision level to the lesser trochanter, by use of a connecting jig. Using the latter, two sliding proximal screws are passed up the femoral neck and the plate is fixed to the femur shaft with three screws. The insertion technique is designed to minimise the damage to soft tissues ([Gotfried 2000](#)).

The type of external fixator reviewed here is held outside the thigh by two pairs of pins. One pair is passed up the femoral neck under X-ray control. The other pair is placed in the femur. The fixator is left in place until the fracture has healed, which usually takes about three months. It is then removed under local anaesthesia, generally as an outpatient procedure.

Why it is important to do this review

There remains continuing controversy over the choice of implant for extracapsular hip fractures. Complications related to failure of the implant holding the fracture in place whilst fracture healing takes place continue to be reported with an incidence of 3% to 10% ([Parker 2002](#)). These complications are increased in the more comminuted (unstable fractures). In the last decade, there have been a number of new implants that are aimed at reducing the occurrence of fracture healing complications. This is an update of a Cochrane review first published in 1998, and last updated in 2005.

OBJECTIVES

To assess the relative effects of different types of extramedullary fixation implant, as well as external fixators, for treating extracapsular proximal femoral (hip) fractures in adults.

Based on trial availability, the following comparisons were tested.

1. Fixed nail plates versus the sliding hip screw (SHS).
2. The RAB plate versus the SHS.
3. The Pugh nail versus the SHS.
4. The Medoff plate versus the SHS.
5. The Medoff plate versus other screw-plate systems.
6. The Gotfried percutaneous compression plate versus the SHS.
7. External fixators versus the SHS.

METHODS

Criteria for considering studies for this review

Types of studies

All randomised controlled trials comparing different methods of extramedullary or external fixation. Quasi-randomised trials (for example, allocation by alternation or date of birth) and trials in which the treatment allocation was inadequately concealed were also considered for inclusion.

Types of participants

Skeletally mature patients with an extracapsular proximal femoral fracture.

Types of interventions

The implants considered so far were those compared within randomised trials identified for this review. These are:

- Fixed nail plate (e.g. Jewett and McLaughlin nail plates)
- Resistance Augmented Bateau (RAB) plate
- Pugh nail plate
- Medoff plate
- Sliding hip screw (SHS)
- Sliding hip screw (SHS) with a trochanteric stabilising plate *
- Dynamic compression screw/plate *
- Gotfried percutaneous compression plate (PCCP)
- External fixator

* Note, as explained below, these were not included in direct comparisons.

Types of outcome measures

The following outcome measures were sought:

1. Operative details

- length of surgery (in minutes)
- operative blood loss (in millilitres)
- post-operative blood transfusion (in units)
- number of patients transfused
- fall in haemoglobin levels
- radiographic screening time (in seconds)

2. Fracture fixation complications

- fracture of the femur (around or below the implant)
- cut-out of the implant proximally (penetration of the implant from the proximal femur either into the hip joint or external to the femur)
- non-union of the fracture within the follow-up period (the definition of non-union was that used within each individual study, and includes pseudoarthrosis)
- avascular necrosis of the femoral head
- mechanical failure of the implant (includes breakage, bending or disassembly of the implant)
- fracture fixation failure rate (sum of the above five and other mentioned implant related complications that impaired healing of the fracture)

- reoperation (within the follow-up period of the study)
- need for removal of implant due to symptoms after fracture healing
- superficial wound infection (infection of the wound for which there is no evidence that the infection extends to the site of the implant)
- deep wound infection (infection around the implant)

3. Post-operative course and complications

- pneumonia
- pressure sores
- deep vein thrombosis
- pulmonary embolism
- thromboembolic complications (sum of the above two)
- any medical complication (as detailed in each individual study)
- length of hospital stay (in days)
- cost of treatment

4. Anatomical restoration

- shortening (> 2 cm)
- varus deformity
- external rotation deformity (> 20 degrees)

5. Final outcome measures

- mortality (within the follow-up period of the study)
- pain (persistent pain at the final follow-up assessment)
- failure to return to living at home - failure to regain mobility
- other measures of mobility and function (activities of daily living, etc)

Search methods for identification of studies

Electronic searches

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (July 2011), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2011, Issue 2), MEDLINE (1966 to June Week 4 2011), EMBASE (1988 to 2011 Week 25), the National Research Register Issue 3, 2005 (now archived), the [WHO International Clinical Trials Registry Platform](#) (January 2013) and our own reference databases. No language restriction was applied and translations were obtained when necessary.

For this update, the MEDLINE (OVID Online) subject-specific search was combined with the sensitivity- and precision-maximizing version of the Cochrane Highly Sensitive Search Strategy for identifying randomised trials ([Lefebvre 2011](#)) (see [Appendix 1](#)). The current search strategies for *The Cochrane Library* and EMBASE are also shown in [Appendix 1](#). Details of the search strategies used for previous versions of the review are reported in [Appendix 2](#).

Searching other resources

We undertook a general perusal of locally accessible conference proceedings: for example, British Orthopaedic Association Congress 2000, 2001, 2002 and 2003. We also scrutinised weekly downloads of "Fracture" articles in new issues of 17 journals (*Acta Orthop Scand*; *Am J Orthop*; *Arch Orthop Trauma Surg*; *Clin J Sport Med*; *Clin Orthop*; *Emerg Med Clin North Am*; *Foot Ankle Int*; *Injury*;

J Accid Emerg Med; J Am Acad Orthop Surg; J Arthroplasty; J Bone Joint Surg Am; J Bone Joint Surg Br; J Foot Ankle Surg; J Orthop Trauma; J Trauma; Orthopedics) from [AMEDEO](#) (to September 2005). We also searched reference lists of articles.

Data collection and analysis

Selection of studies

Both review authors independently screened downloads from electronic databases and other sources for potentially eligible trials. We then independently selected trials for inclusion, usually based on full text reports. Trial authors were approached for further details of trial methods where necessary. Any disagreement was resolved by discussion.

Data extraction and management

Data for the outcomes listed above were independently extracted by two review authors and any differences resolved through discussion. Requests for additional information (methodological and outcome) were sent to trialists when necessary.

Assessment of risk of bias in included studies

For this update of the review, risk of bias was independently assessed, without masking of the source and authorship of the trial reports for all included trials, by both review authors. We used the tool outlined in the Cochrane Handbook for Systematic Reviews of Interventions ([Higgins 2011](#)). This tool incorporates assessment of randomisation (sequence generation and allocation concealment), blinding (of participants and treatment providers, and outcome assessors), completeness of outcome data, selection of outcomes reported and other sources of bias. We considered subjective outcomes (e.g. pain) and objective outcomes (death, reoperation) separately in our assessment of blinding of outcome assessment; and short term and longer-term outcomes separately in our assessment of completeness of outcome data. We assessed risk of bias related to surgeons' experience with the devices prior to commencement of the trial, this was generally rated as 'high' where there was a lack of information on measures taken to avoid learning curve problems, often in the context of a large number of operating surgeons. All differences were resolved by discussion.

Measures of treatment effect

For dichotomous outcomes, we report risk ratios (RR) with 95% confidence intervals and for continuous outcomes, mean differences (MD) and 95% confidence intervals.

Dealing with missing data

Where the number of participants providing data for any particular outcome was reported, we used these data. In studies for which a number of events were reported, but the denominator was unclear, we used numbers randomised or alive at follow-up. Sensitivity analyses using numbers randomised were done for any outcome for which denominators other than number randomised had been used, in order to assess any impact of missing data on results.

Assessment of heterogeneity

Heterogeneity between comparable trials was assessed by visual inspection of the forest plots and tested using a standard χ^2 test, with additional consideration of the I^2 statistic ([Higgins 2003](#)).

Data synthesis

In the first instance, results of comparable groups of trials were pooled using the fixed-effect model using 95% confidence intervals. However, particularly, where there was unexplained heterogeneity, the results for the random-effects model were presented when there is significant heterogeneity ($P < 0.10$; provisionally $I^2 > 50\%$) in the results of individual trials.

Subgroup analysis and investigation of heterogeneity

We set out a priori two subgroup analyses: by age groups (initially, under versus over 65 years) and by type of fracture (intertrochanteric versus subtrochanteric). To test whether the subgroups are statistically significantly different from one another, we planned to inspect the overlap of confidence intervals and perform the test for subgroup differences available in RevMan.

Sensitivity analysis

There were insufficient data to perform exploratory sensitivity analyses, including those based on allocation concealment and the reporting of surgical experience.

RESULTS

Description of studies

Results of the search

For this search (completed July 2011), we screened a total of 1030 records from the following databases: Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (17 records); Cochrane Central Register of Controlled Trials (166), MEDLINE (154) and EMBASE (693). A further 286 records for 270 trials were screened from a search of the [WHO International Clinical Trials Registry Platform](#) conducted in January 2013.

Upon study selection, four more trials have been included ([Karn 2006](#); [McCormack 2010](#); [Peyser 2007](#); [Yang 2011](#)). In addition, seven further trials have been excluded (([Kumar 2006](#); [Lahav 2007](#); [Li 2010](#); [Ouyang 2010](#); [Romero 2008](#); [Weisbrot 2005](#); [Zhen 2010](#)) and one placed in studies awaiting classification ([ChiCTR 2011](#)).

In all there are 18 included studies, 14 excluded studies and one study, available as a retrospective trial registration, awaiting classification.

Included studies

Of the 18 included studies, 17 were reported in full publications within orthopaedic journals. The exception was reported in conference abstracts only ([McCormack 2010](#)). The trials were conducted in one of 10 countries: Belgium (1 trial), Canada (1), Greece (1), Israel (1), Italy (1), Nepal (1), Spain (1), Sweden (4), UK (5), USA (2). All were single centre studies except for [Bannister 1990](#) (2 centres), and [Lunsjo 1999](#) and [Lunsjo 2001](#) which were both run in the same eight centres in Sweden.

These trials involved 2615 participants with 2619 fractures. [Lunsjo 2001](#) and [Lunsjo 1999](#) were two parts of a large multicentre trial ([Lunsjo 1997](#)); intertrochanteric fractures were only included in [Lunsjo 2001](#) and subtrochanteric fractures exclusively in [Lunsjo 1999](#). Aside from [Lunsjo 1999](#), the studies included only trochanteric fractures; however, 16 (7%) of the trochanteric fractures in [Watson 1998](#) had subtrochanteric extension. Studies

of trochanteric fractures included both stable and unstable trochanteric fractures, except three studies ([Buciuto 1998](#); [Lunsjo 2001](#); [McCormack 2010](#)) that included unstable fractures only.

The mean ages of the trial participants in individual trials ranged from 67 ([Karn 2006](#)) to 84 years, and the proportion of males varied from 0% to 50% ([Karn 2006](#)).

Comparisons

Seven comparisons were made.

Fixed nail plates versus the SHS

Three UK-based studies involving 355 participants compared a fixed nail plate, either the Jewett nail plate ([Bannister 1990](#); [Esser 1986](#)) or the McLaughlin nail plate ([Pitsaer 1993](#)), with the SHS.

Resistance augmented bateaux (RAB) plate versus the SHS

Two studies, based in Sweden ([Buciuto 1998](#)) and Spain ([Lizaur Utrilla 1998](#)), involving 433 participants, compared the RAB plate with the SHS.

Pugh nail versus the SHS

One UK-based study with 100 participants compared the Pugh nail with the SHS ([McLaren 1991](#)).

Medoff sliding plate versus the SHS

Three studies with 455 participants (459 fractures) compared the Medoff plate with the SHS ([McCormack 2010](#); [Olsson 2001](#); [Watson 1998](#)). These were based respectively in Canada, Sweden and the USA.

Medoff sliding plate versus any of three screw-plate systems

[Lunsjo 1999](#) and [Lunsjo 2001](#) were reports of a multicentre study from eight hospitals in Sweden of 676 participants (see [Lunsjo](#)

[1997](#)) split according to fracture type, either unstable trochanteric fracture ([Lunsjo 2001](#): 569 participants) or subtrochanteric fracture ([Lunsjo 1999](#): 107 participants). The choice of implant compared against the Medoff plate was either a SHS, SHS and stabilising plate or a dynamic compression screw (DCS). The exact implant used from these three was at the preference of the attending surgeon.

Gotfried percutaneous compression plate (PCCP)

Four studies ([Janzing 2002](#); [Kosygan 2002](#); [Peyser 2007](#); [Yang 2011](#)), conducted respectively in Belgium, UK, Israel and the USA, compared the Gotfried percutaneous compression plate (PCCP) with a sliding hip screw in a total of 396 people).

Pertrochanteric external fixator versus the SHS

Three studies ([Karn 2006](#); [Moroni 2005](#); [Vossinakis 2002](#)), conducted respectively in Nepal, Israel and Greece, compared a pertrochanteric external fixator with the sliding hip screw in a total of 200 participants. In [Moroni 2005](#), the fixator pins were hydroxyapatite coated.

Further details of each of the included trials are given in the [Characteristics of included studies](#).

Excluded studies

The reasons for excluding 14 studies are given in the [Characteristics of excluded studies](#). Ten studies were excluded because they were either definitely not randomised or very likely not randomised trials. Three trials ([Enskog 1999](#); [Kumar 2006](#); [Weisbrot 2005](#)) reported in conference abstracts only provided insufficient data to include these at this time. The comparison of one trial was outside the scope of this review.

Risk of bias in included studies

See [Figure 1](#) and [Figure 2](#) for summary of assessments.

Figure 1. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias): Subjective outcomes	Blinding of outcome assessment (detection bias): Objectives outcomes	Incomplete outcome data (attrition bias): Short-term outcomes	Incomplete outcome data (attrition bias): Longer-term outcomes	Selective reporting (reporting bias)	Surgeons' experience with trial operations
Bannister 1990	?	?	?	-	?	-	-	-	?
Buciuto 1998	?	?	?	-	?	-	-	-	?
Esser 1986	+	?	?	-	?	-	-	-	?
Janzing 2002	?	+	?	-	?	?	?	?	?
Karn 2006	?	?	?	-	?	-	-	-	?
Kosygan 2002	?	?	?	-	?	+	+	+	+
Lizaur Utrilla 1998	-	-	?	-	?	-	-	+	+

Figure 1. (Continued)

Lizaur Utrilla 1998	-	-	?	-	?	-	-	+	+
Lunsjo 1999	?	?	?	-	?	+	-	+	-
Lunsjo 2001	?	?	?	-	?	+	-	?	?
McCormack 2010	?	?	?	-	?	-	-	-	?
McLaren 1991	-	-	?	-	?	?	-	-	?
Moroni 2005	+	+	?	-	?	?	-	?	?
Olsson 2001	?	?	?	-	?	?	?	+	?
Peyser 2007	+	+	?	-	?	+	-	+	+
Pitsaer 1993	?	?	?	-	?	?	-	-	?
Vossinakis 2002	?	?	?	-	?	+	+	+	?
Watson 1998	-	-	?	-	?	-	-	-	?
Yang 2011	+	+	?	-	?	?	-	?	?

Figure 2. Risk of bias summary: judgements about each risk of bias item for each included study.

Allocation

Selection bias, both in terms of sequence generation and allocation concealment, was judged as high for the three quasi-randomised trials whose allocation was based on even or odd medical record numbers (McLaren 1991; Watson 1998) or the admission sequence of patients (Lizaur Utrilla 1998).

Random sequence generation was confirmed in four studies (Esser 1986; Moroni 2005; Peyser 2007; Yang 2011), which used computer generated random numbers or randomisation. The method of random sequence generation was not reported in the remaining 'randomised' studies.

Allocation concealment was considered assured in four studies, three of which used sealed numbered envelopes (Janzing 2002; Peyser 2007; Yang 2011); treatment assignment was confirmed as being independent of the surgeon in Moroni 2005. While insufficient details were provided to assign a low risk of bias rating, allocation concealment was possible in the three studies that used sealed envelopes opened in the operating theatre (Kosygan 2002; Lunsjo 1999; Lunsjo 2001) as well as Vossinakis 2002, which used sealed numbered envelopes. The method of randomisation was not stated in five studies (Bannister 1990; Buciuto 1998; Karn 2006; McCormack 2010; Pitsaer 1993). There was insufficient information to judge concealment of allocation in Esser 1986, which used computer generated random numbers and in Olsson 2001 which referred to the drawing of an 'unseen card'.

Blinding

All trials were rated as 'unclear' for performance bias related to lack of blinding of the surgeons and trial participants. All trials were rated as being at high risk of detection bias for subjective outcomes and unclear risk for objective outcomes. While a general allowance has to be made for inadequate reporting, it is likely that assessor blinding was not considered in any of these trials. Independent assessment of fracture healing was reported in Lunsjo 1999 and Lunsjo 2001 but the type of implant used would have been apparent at the time of assessment.

Incomplete outcome data

Seven trials were judged as being at high risk of attrition bias for both short and longer-term outcomes (Bannister 1990; Buciuto 1998; Esser 1986; Karn 2006; Lizaur Utrilla 1998; McCormack 2010; Watson 1998). Serious intention-to-treat problems were encountered in five studies (Bannister 1990; Janzing 2002; Lizaur Utrilla 1998; Pitsaer 1993; Watson 1998) due to data being excluded from baseline and subsequent analyses for trial participants who had died or were lost to follow-up. Strict intention-to-treat analysis was not carried out in Olsson 2001 since no data were provided for three people with associated cervical or subtrochanteric fractures.

Selective reporting

Based mainly on an assessment of limitations in outcome reporting, eight trials were considered at high risk of selective reporting, four at unclear risk, and six trials at low risk (Kosygan 2002; Lizaur Utrilla 1998; Lunsjo 1999; Olsson 2001; Peyser 2007; Vossinakis 2002).

Other potential sources of bias

Three trials were considered at low risk of bias in terms of surgeon's experience for the implants under investigation (Kosygan 2002; Lizaur Utrilla 1998; Peyser 2007). All three surgeons in Kosygan 2002 had received instruction on the use of the new implant (the Gotfried percutaneous compression plate); the first two cases by each surgeon were not included in the study. There was also some attempt made by the four surgeons in Lizaur Utrilla 1998 to familiarise themselves with the operative techniques for the RAB plate beforehand; the first 10 cases were not included in analysis. Peyser 2007 stated all surgeons were experienced in both techniques. The remaining trials were considered at unclear risk of bias, except for Lunsjo 1999 which stated that some of the surgeons had "little, if any, experience" with the Medoff plate.

Effects of interventions

Outcomes for which data were available within individual trials are listed in the [Characteristics of included studies](#) and graphically. The results for the different implants compared against the SHS are considered separately. Results were viewed using fixed-effect and random-effects models. Unless otherwise indicated, the risk ratios (RR) together with 95% confidence intervals (CI) using the fixed-effect model are presented below.

Fixed nail plates versus the SHS

Three studies made this comparison (Bannister 1990; Esser 1986; Pitsaer 1993).

Operative details

The only study to report on length of surgery was Esser 1986, with an average operating time of 48 minutes for the Jewett nail plate against 57 minutes for the SHS, a difference that was reported not to be significant when surgeon's experience and reduction type were taken into consideration. No study reported on operative blood loss or transfusion requirements.

Fracture fixation complications

These were poorly documented in all studies; the available data for the various outcomes are presented in [Analysis 1.1](#). Pitsaer 1993, the only study to provide separate data on cut-out, showed a non-significant difference between the two groups for the 59 survivors (RR 0.63, 95% CI 0.13 to 3.20). There were however 11 cases of bending or breakage of the McLaughlin nail plate compared with no cases for the SHS. Bannister 1990 reported on non-union, early reoperations and the total fixation failure rate, but only gave the results for the 86 survivors who had complete clinical and radiographical data. For these, there was a significant increase in fixation failure, defined as cut-out or bending or breaking of the implant, for the Jewett nail plate (25/36 versus 8/50). Pooling of the results from these two studies showed a significantly increased fixation failure rate for the fixed nail plate (RR 4.27, 95% CI 2.44 to 7.45). There was no statistically significant difference in pooled reoperation rates (6/62 versus 4/83: RR 1.97, 95% CI 0.59 to 6.58). Esser 1986 reported that technical complications at the time of surgery were more common for the SHS (24% versus 2%), which may be a learning curve issue as the surgeons were less experienced in the use of the SHS. Information on the later fixation complications was contradictory. Only Bannister 1990 reported on wound infection, again only for survivors, but did not give comparative data.

Post-operative complications

No study reported on the complications of pneumonia, pressure sores, thromboembolic or other medical complications. Only [Esser 1986](#) reported on length of hospital stay, indicating that there was no statistically significant difference between the two groups. [Bannister 1990](#) indicated that there was no difference in bed occupancy or rehabilitation rates.

Anatomical restoration

This was not reported in any of the studies, aside from a reference to leg shortening being less in stable compared with unstable fractures in [Pitsaer 1993](#).

Final outcome measures

Both [Bannister 1990](#) and [Pitsaer 1993](#) reported, without providing comparative data, that there was no difference in mortality between the two implants. Similarly, the available data show that there was no statistically significant difference in mortality in [Esser 1986](#) (see [Analysis 1.2](#): RR 1.33, 95% CI 0.60 to 2.91). Both [Bannister 1990](#) and [Esser 1986](#) reported a tendency to more pain after the Jewett nail plate but the difference was not statistically significant using available data (7/36 versus 4/42: RR 2.04, 95% CI 0.65 to 6.42). [Pitsaer 1993](#) stated that there was no significant difference in pain at follow-up. No study reported on the number of trial participants who failed to return to living at home. [Bannister 1990](#) and [Pitsaer 1993](#) stated, without data, that there was no significant difference in the recovery of pre-fracture walking ability between groups. However [Esser 1986](#) reported the greater proportion (88% versus 61%) of people treated with the SHS who returned to their pre-fracture mobility was statistically significant ($P < 0.05$). [Analysis 1.2](#) presents the overall mobility data for [Esser 1986](#); there was no statistically significant difference between the two implants for impaired mobility (15/36 versus 11/42: RR 1.59, 95% CI 0.84 to 3.01).

Resistance augmented bateaux (RAB) plate versus the SHS

Two studies made this comparison ([Buciuto 1998](#); [Lizaur Utrilla 1998](#)).

Operative details

The median operative times for the two procedures were almost identical in [Buciuto 1998](#) (64 versus 63 minutes). The difference in the mean operative times in favour of the SHS group in [Lizaur Utrilla 1998](#) was indicated as being statistically significant (50 versus 43 minutes; reported $P = 0.02$).

[Buciuto 1998](#) reported median operative blood loss was 400 millilitres for both the RAB plate and the SHS. [Lizaur Utrilla 1998](#) reported a statistically significantly higher blood loss in the RAB plate group (1045 ml versus 985 ml; reported $P = 0.02$). This was reflected in the greater numbers of RAB plate patients given transfusion in [Lizaur Utrilla 1998](#) (see [Analysis 2.1](#): 46/82 versus 33/84; RR 1.43, 95% CI 1.03 to 1.98).

The mean radiographic screening time for [Lizaur Utrilla 1998](#) was 163 seconds for the RAB versus 145 seconds for the SHS (reported $P = 0.18$).

Fracture fixation complications

These outcomes were only reported for trial participants who were included in the final analysis of each trial; the available data for the

various outcomes are presented in [Analysis 2.2](#). Twice as many RAB plate operations (14 versus 7) were reported as being technically difficult in [Lizaur Utrilla 1998](#). Operative complications, comprising two fractures of the greater trochanter and two cases in which the tip of the nail did not settle on the nail support, were only reported for participants of the RAB plate group in [Lizaur Utrilla 1998](#) (RR 9.22, 95% CI 0.50 to 168.52). Similarly, the two cases of implant breakage and two cases of implant disassembly occurred in the RAB plate group of this trial. Cut-out in the two trials was reported for six participants of RAB plate group and 11 participants of the SHS group (RR 0.57, 95% CI 0.22 to 1.49). One study, [Buciuto 1998](#) accounted for almost all of these cut-outs with only one in each group for [Lizaur Utrilla 1998](#). Other reported complications, presented in [Analysis 2.2](#), of non-union, avascular necrosis and fracture distal to the plate showed no notable differences between the two implants.

The pooled fixation failure rate (excluding cases of varus angulation) was similar in the two groups (21/173 versus 22/179; RR 0.99, 95% CI 0.56 to 1.74). (This assumes that each complication occurred in separate people in [Lizaur Utrilla 1998](#).) However, these results were significantly heterogeneous ($P = 0.02$): where just over half as many fixation failures occurred in the RAB plate group as in the SHS group (8 versus 16) in [Buciuto 1998](#), the converse (13 versus 6) occurred in [Lizaur Utrilla 1998](#). Similarly, the reoperation rates of two trials were significantly heterogeneous ($P = 0.02$); these were in opposite directions although the pooled data showed similar numbers for the two intervention groups (21/173 versus 26/179; RR 0.84, 95% CI 0.49 to 1.43). Nearly three quarters of reoperations were in the study of [Buciuto 1998](#) and included 20 cases (9 RAB, 11 SHS) where the implant was removed after the fracture had healed due to local discomfort (lateral tenderness or unspecified leg pain, or both). A separate publication by [Buciuto \(Buciuto 1997\)](#), which documented the outcome of these 20 participants, reported seven spontaneous fractures of the femoral neck and drew attention to this outcome "as a serious and frequent complication after implant removal".

[Lizaur Utrilla 1998](#) reported two cases of superficial wound infection in each group. Deep wound infection, reported by both studies, occurred in three people in the RAB group and four in the SHS group (see [Analysis 2.3](#): RR 0.77, 95% CI 0.18 to 3.41).

Post-operative complications

[Lizaur Utrilla 1998](#) reported two cases of urinary tract infection in the RAB plate group and three cases of thrombophlebitis in each group (see [Analysis 2.4](#)).

Anatomical restoration

Similar numbers of participants (4 versus 5) in the two groups had a varus angulation of more than 19 degrees in [Lizaur Utrilla 1998](#), whereas varus angulation of greater than 10 degrees occurred in one person in the RAB plate group compared with six people in the SHS group in [Buciuto 1998](#). Data pooling resulted in a statistically non significant difference (see [Analysis 2.5](#): 6/173 versus 10/179; RR 0.62, 95% CI 0.23 to 1.67), but also featured marginally significant heterogeneity ($P = 0.10$) when measured using standard χ^2 test, and moderate heterogeneity with regard to the I^2 statistic ($I^2 = 62.2\%$). [Lizaur Utrilla 1998](#) reported the mean external rotation deformity was equal in both groups. [Lizaur Utrilla 1998](#) found no difference in the mean leg shortening in the two groups (2.6 cm versus 2.4 cm; $P = 0.65$). In contrast, [Buciuto 1998](#), who defined

shortening as more than 2.5 centimetres, found that shortening was significantly increased in the SHS group (see [Analysis 2.5](#): 2/91 versus 15/95; RR 0.14, 95% CI 0.03 to 0.59). All 17 participants with leg shortening reported significant problems due to the resulting leg-length discrepancy.

Final outcome measures

Mortality at one year was slightly but not statistically significantly less in the RAB plate group (see [Analysis 2.6](#): 25/211 versus 36/222; RR 0.73, 95% CI 0.46 to 1.18). Functional outcome measures were not reported in [Buciuto 1998](#). Post-operative mobility was rated in [Lizaur Utrilla 1998](#); incomplete data provided for an unspecified follow-up time indicated no significant difference between the two groups.

Pugh nail versus the SHS

One study with 100 participants made this comparison ([McLaren 1991](#)).

Operative details

[McLaren 1991](#) reported that there was no significant difference in mean operative times (53 versus 57 minutes) between the two implants. Operative blood loss or transfusion requirements were not reported.

Fracture fixation complications

The only case of cut-out reported was in the Pugh nail group. At six-months follow up, there was no statistically significant difference in the overall fixation failure rate, which included delayed healing, cut-out and varus angulation, between the two groups (see [Analysis 3.1](#): 2/40 versus 4/44; RR 0.55, 95% CI 0.11 to 2.84). Technical problems at surgery were encountered in three out of 30 participants of the Pugh nail group and 8 out of 50 participants of the SHS group. There were seven versus four "unsatisfactory fixations" in the Pugh nail and SHS groups respectively. However, only one of the early unsatisfactory fixations in each group resulted in a longer-term problem. The reoperation rate was not reported. The only case of deep wound infection was seen in the SHS group.

Post-operative complications

The only medical complication reported in [McLaren 1991](#) was that of one venous thrombosis in each group. The mean length of hospital stay was reported not to be different between the two groups (23.3 versus 25.1 days).

Anatomical restoration

This was not reported.

Final outcome measures

There was no significant difference in mortality between the two groups (see [Analysis 3.4](#): 10/50 versus 6/50: RR 1.67, 95% CI 0.66 to 4.24). Pain classified as severe, moderate and mild at follow up was found in similar numbers in the two groups (see [Analysis 3.4](#): 3/40 versus 4/44; RR 0.82, 95% CI 0.20 to 3.46), as was the use of walking aids.

Medoff sliding plate versus the SHS

Three studies made this comparison ([McCormack 2010](#); [Olsson 2001](#); [Watson 1998](#)).

Operative details

[Watson 1998](#) reported that the Medoff plate was associated with a significantly increased operating time (mean values: 135 versus 90 minutes). [McCormack 2010](#) also reported a longer operative time for the Medoff plate (61 minutes versus 50 minutes) whereas [Olsson 2001](#) found no significant difference (median values: 58 versus 55 minutes; reported $P = 0.23$). Similarly, operative blood loss was reported to be significantly greater in the Medoff plate group in [Watson 1998](#) (mean values: 350 versus 200 ml); reflected also in [McCormack 2010](#), which reported an increased transfusion for the Medoff group. This was not the case for [Olsson 2001](#) (median values: 225 versus 200 ml; reported P value = 0.07). The fall in haemoglobin levels within three days from surgery was similar in the two groups of [Olsson 2001](#) (median values: 33 g/l versus 30 g/l).

Fracture fixation complications

Fewer cut-outs occurred in the Medoff plate group in all three trials (see [Analysis 4.1](#)). A further three implant failures occurred in the SHS group of [Watson 1998](#) due to detachment of the plate from the femur. There were two fracture non-unions in the Medoff plate group of [McCormack 2010](#). Pooling of results for all reported complications of the fracture showed a statistically significantly lower incidence for the Medoff plate (see [Analysis 4.4](#): 4/199 versus 17/237; RR 0.30, 95% CI 0.11 to 0.81). All the fracture fixation complications reported were for unstable fractures. While there were fewer reoperations in the Medoff plate group, the evidence was inconclusive (see [Analysis 4.5](#): 2/130 versus 5/146; RR 0.51, 95% CI 0.12 to 2.23).

[Watson 1998](#) reported without data that the time to union was the same in both groups. [Olsson 2001](#) reported on the extent of slide of the lag screw and degree of femoral medialisation on the X-rays; these were increased for those fractures treated with the SHS.

Two SHS group participants had wound infection in [Olsson 2001](#); this outcome was not reported in [McCormack 2010](#) and [Watson 1998](#).

Post-operative complications

[McCormack 2010](#) and [Watson 1998](#) did not report on these. [Olsson 2001](#) just stated that there were no cases of thromboembolism. Both [Watson 1998](#) and [Olsson 2001](#) reported that there was no difference in the length of hospital stay between groups.

Anatomical restoration

These outcomes were not reported in [McCormack 2010](#) and [Watson 1998](#). [Olsson 2001](#) reported marginally greater femoral shortening for unstable fractures in the Medoff group (mean values: 15 mm versus 11 mm; reported $P = 0.03$).

Final outcome measures

[McCormack 2010](#) and [Watson 1998](#) did not provide mortality data split by treatment group. By four months, six had died in the Medoff group compared with 10 in the SHS group in [Olsson 2001](#) (see [Analysis 4.7](#)).

[Watson 1998](#) reported without data that there was no difference between the two groups in return to pre-fracture ambulatory status, or in post-operative living status or pain. [Olsson 2001](#) also reported similar numbers in both groups failing to return to living in their own home or to independent walking (see [Analysis 4.7](#)).

McCormack 2010 reported very similar 'Hip Fracture Functional Recovery Scores' (Zuckerman 2000) in the two groups at six months (49% versus 51%).

Medoff sliding plate versus any of three screw-plate systems

Lunsjo 1999 and Lunsjo 2001 were reports of one study of 676 participants (see Lunsjo 1997) split according to fracture type, either unstable trochanteric fracture (Lunsjo 2001) or subtrochanteric fracture (Lunsjo 1999). In these two studies, the Medoff screw-plate was compared with one of three screw-plate systems (sliding hip screw (SHS), the SHS with a trochanteric stabilising plate (TSP) and the dynamic compression screw (DCS)); the latter being chosen by the operating surgeon. Since the choice of which one of the three screw-plate systems was selected was not random, individual results for these are not presented despite being made available in the trial reports. This is because surgeons' preferences may have generated systematic differences between the three subgroups; for instance, it is possible that the more complex fractures were preferentially treated with one of the three screw-plate systems.

Of 569 participants with unstable trochanteric fractures in Lunsjo 2001, 268 were allocated the Medoff plate and 301 were given one of three screw plates (the operating surgeon chose the SHS in 238 cases, the TSP in 14 cases and the DCS in 49 cases). Of 107 people with subtrochanteric fractures in Lunsjo 1999, 55 were allocated the Medoff plate and 52, one of three screw plates (the operating surgeon chose the SHS in 32 cases, the TSP in 8 cases and the DCS in 12 cases). The latter group is referred to as the screw-plate group in the following.

Operative details

While Lunsjo 2001 reported on the differences between the Medoff plate group and each of the three screw-plate groups in length of surgery and intra-operative blood loss, the overall differences between the Medoff plate group and the screw-plate group in these outcomes were not reported.

Lunsjo 1999 reported no significant difference in the median length of surgery for the Medoff plate (75 minutes) compared with that for the three screw-plate systems (87 minutes). Median values for operative blood loss, blood loss from the wound drains and total blood loss were also reported as not being significantly different for the two groups.

Fracture fixation complications

In Lunsjo 2001, there were 15 cases of cut-out in the Medoff plate group and eight in the screw-plate group (see Analysis 5.1). Non-union of the fracture occurred in three participants of the Medoff group and one person in the screw-plate group (see Analysis 5.2). Three cases of breakage or loosening of the implant were reported in the screw plate group. The overall failure of fracture fixation was not statistically significantly different between groups (see Analysis 5.4: 18/268 versus 12/301; RR 1.68, 95% CI 0.83 to 3.43). Reoperation was required for nine patients in the Medoff group compared with seven in the screw-plate group (see Analysis 5.5: RR 1.44, 95% CI 0.55 to 3.82). There were no significant differences between the two groups in the incidences of either superficial (one versus two cases) or deep wound infection (one versus three cases).

In Lunsjo 1999, there were no cases of cut-out in the Medoff plate group, compared with four in the screw-plate group (see Analysis 5.1). Non-union of the fracture occurred in one person in the screw-plate group. Breakage of the implant occurred in one participant of the Medoff group compared with three participants of the screw-plate group. No fracture occurred below the implants. Overall failure of fracture fixation was significantly less common in the Medoff group compared with the screw-plate group (see Analysis 5.4: 1/55 versus 8/52; RR 0.12; 95% CI 0.02 to 0.91). Reoperation was required for one person in the Medoff group compared with six in the screw-plate group (see Analysis 5.5: RR 0.16; 95% CI 0.02 to 1.26). There were no significant differences between the two groups in the incidences of either superficial or deep wound infection.

Both trials reported on the numbers of deviations from routine operations; these were greater in the Medoff group in Lunsjo 2001 (77/268 versus 29/301) but similar in both groups in Lunsjo 1999 (34/55 versus 36/52). These deviations included the use of the locking set screw in the Medoff group for trochanteric fractures or failure to use the locking set screw for subtrochanteric fractures (attributed to inexperience with the Medoff plate) and supplementary fixation (such as use of cerclage wire) in the screw-plate group.

Post-operative complications

All trial participants were given low molecular weight heparin and spinal anaesthesia was routine in all hospitals. Both trials only reported thromboembolic complications, there being no significant difference between the two groups in either Lunsjo 2001 (0/268 versus 1/301) or Lunsjo 1999 (3/55 versus 1/52).

The proportion of patients allowed to weight bear (as tolerated) immediately after the operation was higher in the Medoff group for both Lunsjo 2001 (255/268 versus 269/301) and Lunsjo 1999 (43/55 versus 31/52), but there was no mention of the criteria applied. The differences in the length of hospital stay for the two groups were reported as not statistically significant in both trials.

Anatomical restoration

These outcomes were not reported in either trial.

Final outcome measures

Figures for mortality at one year from injury are detailed in Analysis 5.9 and show no statistically significant difference between the two groups for either Lunsjo 2001 (60/268 versus 72/301; RR 0.94, 95% CI 0.69 to 1.26) or Lunsjo 1999 (9/55 versus 7/52; RR 1.22, 95% CI 0.49 to 3.03). Neither was there any statistically significant difference between the two groups of either trial in the numbers of survivors available for follow up who failed to return home (see Analysis 5.10) nor in the numbers who required walking aids having walked without aids before their fracture (see Analysis 5.11); although there is tendency for fewer Medoff plate patients with unstable trochanteric fractures to regain independent walking, the missing data from previously ambulant patients who were lost to follow up may change this.

Gotfried percutaneous compression plate (PCCP)

Four studies made this comparison (Janzing 2002; Kosygan 2002; Peyser 2007; Yang 2011).

The fractures of three people allocated to the PCCP group in [Kosygan 2002](#) could not be reduced satisfactorily and were fixed with a SHS. Applying the intention-to-treat principle, the separate data provided in the trial report for these three people have been included in the results for the PCCP group. [Janzing 2002](#) had one such case. An additional anti-rotation screw was used for all participants of the SHS group in [Janzing 2002](#); in 17 participants, SHS fixation was augmented with a stabilising plate. (The interim results for 71 participants of [Janzing 2002](#) available in a conference abstract ([Brandt 2001](#)) are not presented here.) In [Peyser 2007](#), 11 patients whose fracture could not be reduced using closed methods were excluded before randomisation and a further patient randomised to the PCCP group was excluded from the analysis due to a failed closed reduction.

Operative details

For these outcomes, [Janzing 2002](#) only provided the results for the 83 participants who were available at one-year follow up. The results of the three PCCP participants given an SHS in [Kosygan 2002](#) could not be added to the PCCP results.

[Analysis 6.1](#) shows the conflicting and significantly heterogeneous results ($I^2 = 95\%$ if the data are pooled) for length of surgery of the three trials: [Janzing 2002](#) and [Yang 2011](#) found the PCCP quicker to apply and [Kosygan 2002](#) the converse. [Peyser 2007](#) reported no significant difference with a mean of 53 minutes for the PCCP and 51 minutes for the SHS.

Operative blood loss (see [Analysis 6.2](#)) and mean fall in haemoglobin (see [Analysis 6.3](#)) and need for blood transfusion (see [Analysis 6.4](#) and [Analysis 6.5](#)) showed a clear trend to a lower blood loss, fall in haemoglobin and need for blood transfusion for the PCCP. In an interim report, [Janzing 2002](#) found that significantly fewer PCCP group participants required blood transfusion; but no data on this outcome were available in the full report of this study.

[Kosygan 2002](#) found no difference between the two groups in the mean radiographic screening times. (Readers should note that in [Analysis 6.6](#), the standard deviations are based on the interpretation that the data provided in the study report were in minutes rather than seconds.)

Fracture fixation complications

Besides the four people allocated to the PCCP group whose fracture could not be reduced, [Janzing 2002](#) reported two cases presenting additional problems for PCCP fixation. In one person, the screws missed the plate and an open procedure had to be done. In the other person, it was not possible to place the upper lag screw of the PCCP and an alternative screw was used. [Peyser 2007](#) reported that for one patient in the PCCP group, the fracture could not be reduced closed and was treated with a SHS.

Fracture healing complications occurred in similar numbers in both groups as shown in [Analysis 6.7](#). An extra cut-out in the PCCP group of [Kosygan 2002](#) that had become apparent subsequently was reported in response to a letter commenting on the trial ([Gotfried 2003](#)). [Janzing 2002](#) also reported one case of fracture below a SHS and one case where the lag screws of the PCCP backed out necessitating their removal. [Yang 2011](#) reported that there were no fracture fixation complications in either group. There was no statistically significant difference between the two groups

in reoperations for fracture fixation complications (see [Analysis 6.7](#): 8/158 versus 5/171; RR 1.75, 95% CI 0.59 to 5.22).

No difference in the wound infection rate was reported (see [Analysis 6.8](#)). Though an interim analysis of [Janzing 2002](#) found significantly fewer haematomas in the PCCP group, neither this outcome or infection were reported in the full trial report.

Post-operative complications

Data for these were provided for [Kosygan 2002](#) and [Peyser 2007](#). As shown in [Analysis 6.9](#), individually none of the complications showed a statistically significant difference between the two groups.

Hospital stay was not significantly different in the two groups for either [Kosygan 2002](#) (see [Analysis 6.10](#)) or [Peyser 2007](#), who reported a mean stay of 11.1 days for the PCCP versus 10.9 days for the SHS.

Anatomical restoration

The only mention of this was in [Kosygan 2002](#), where one person in the PCCP group and two in the SHS group required a heel raise for leg shortening.

Final outcome measures

Pooled results from the four studies did not show a statistically significant difference between the two groups in mortality (see [Analysis 6.11](#); 30/191 versus 43/204; RR 0.75, 95% CI 0.49 to 1.14).

Pain at final follow up was reported in [Peyser 2007](#), which found a statistically significant reduced pain score (less pain) for those patients treated by the PCCP at six weeks after surgery (P value reported as 0.04), but not at any other time periods assessed (1, 2 days, 5 to 7 days, 12 weeks and 24 weeks). [Yang 2011](#) reported that there was a statistically significant reduction in the pain score (less pain) at three months for those treated with the PCCP, but while there was a trend for less pain at other time periods, the differences were not statistically significant. [Kosygan 2002](#) stated that the requirement for analgesia in the post-operative period was not significantly different between the two groups. [Janzing 2002](#) reported that the difference in the pain scores during the first week (mean visual analogue scale scores: 3.2 versus 4.2; signifying less pain for the PCCP group) were statistically significant.

Data for mobility and residential status available in [Janzing 2002](#) showed no statistically significant differences between the two groups either in the loss of independent mobility or independence (see [Analysis 6.11](#)). [Yang 2011](#) reported a greater percentage of patients treated with the PCCP were discharged directly home (21% versus 3%) and less patients in the PCCP group used assistive walking devices (40% versus 59%).

Pertrochanteric external fixator versus the SHS

Three studies ([Karn 2006](#); [Moroni 2005](#); [Vossinakis 2002](#)) including 200 participants compared a pertrochanteric external fixator with the sliding hip screw. In [Moroni 2005](#), the fixator pins were hydroxyapatite coated.

Operative details

The average length of surgery for the external fixator was significantly less than that for the SHS in all three trials. The data

for [Moroni 2005](#) (MD -30.00 minutes) and [Vossinakis 2002](#) (MD -17.60 minutes) are shown in [Analysis 7.1](#); these are not pooled given the significantly heterogeneous results ($I^2 = 97.1\%$ when pooled). [Karn 2006](#) reported mean surgery times of 29 minutes versus 91 minutes respectively for the external fixator and SHS groups. [Vossinakis 2002](#) reported there was no operative blood loss in participants of the external fixator group whereas those in the SHS group lost an average of 568 ml. This was reflected in the difference between the two groups in the fall in post-operative haemoglobin (0.1 versus 1.5 mg/dl) and number of patients requiring transfusion (1/50 versus 14/50) in this trial. The only patient requiring transfusion in the external fixator group had an upper gastrointestinal bleed. None of the external fixator group but all of the SHS group had transfusion in [Moroni 2005](#). [Karn 2006](#) reported a reduced operative blood loss (33 ml versus 434 ml) for the external fixator group. [Analysis 7.4](#) shows the highly significant pooled result for transfusion in favour of external fixation (RR 0.04, 95% CI 0.01 to 0.22).

Fracture fixation complications

[Moroni 2005](#) did not provide a full account of "postoperative complications" but described a case of varus collapse of the femoral neck after removal of the external fixator and one cut-out in the SHS group. The implications of these postoperative complications, particularly in terms of reoperation, were not given in [Moroni 2005](#). In [Vossinakis 2002](#), comminution of the fracture of the trochanteric region or calcar occurred on insertion of the lag screw in five participants of the SHS group and cut-out of the pins or lag screw occurred in three versus five cases (see [Analysis 7.5](#); cut-out: RR 0.54, 95% CI 0.15 to 1.89). The offending pins were retracted without anaesthesia in the fixator group, whilst the five cases of cut-out in the SHS group all required a second operation: hemiarthroplasty (one case), re-fixation (one case) and implant removal (three cases). Participants of [Vossinakis 2002](#) with external fixators had these removed, without anaesthesia, in the outpatient department when their fractures had healed. No other additional operations were required in the fixator group (reoperation: 0/50 versus 5/50; RR 0.09, 95% CI 0.01 to 1.60). The time to fracture healing was reported as the same for both groups of [Vossinakis 2002](#). [Karn 2006](#) stated all fractures healed.

All studies reported on wound infections (see [Analysis 7.6](#)). [Moroni 2005](#) reported there were no pin-track infections but did not report of deep wound infection. [Karn 2006](#) reported 18 cases of pin tract infection in the fixator group and one case of wound sepsis in the SHS group requiring debridement and closure. In [Vossinakis 2002](#) pin-track infection occurred in 15 participants in the fixator group and superficial sepsis in three participants of the SHS group. Deep wound infection occurred in one person in the SHS group.

Post-operative complications

These were not reported in any of the studies. [Karn 2006](#) stated the hospital stay was shorter by a mean of four days in the fixator group. The mean hospital stays for the two groups were similar in [Moroni 2005](#), but significantly shorter (8.0 versus 16.7 days) for the fixator group in [Vossinakis 2002](#). The data for these latter two studies are presented separately in [Analysis 7.7](#). [Karn 2006](#) reported on cost of treatment, which was less for the fixator group (48 US dollars versus 86 US dollars, reported $P < 0.0001$).

Anatomical restoration

[Moroni 2005](#) reported one person of the external fixator group had varus displacement of the fracture after the fixator was removed. [Vossinakis 2002](#) reported no statistically significant difference between the two groups in the occurrence of varus deformity of between 10 and 20 degrees (12 versus 8 cases) or the extent of leg shortening; data reported for 24 participants only. [Karn 2006](#) reported that both varus deformity of the hip and limb shortening were less for the SHS group at 24 weeks (P value reported as 0.005 and 0.007). Range of movement of the knee but not at the hip was significantly better for the SHS group at 24 weeks (P value 0.04).

Final outcome measures

Similar numbers of participants in the two groups of [Vossinakis 2002](#) had died by six months (see [Analysis 7.8](#): 7/50 versus 8/50; RR 0.88, 95% CI 0.34 to 2.23). Mortality was not reported in [Karn 2006](#).

Both [Moroni 2005](#) and [Vossinakis 2002](#) reported that the fixator was associated with significantly less post-operative pain, recorded at five days post-operatively ([Moroni 2005](#); reported $P < 0.05$) and during initial mobilisation ([Vossinakis 2002](#); reported $P < 0.001$).

[Vossinakis 2002](#) reported that there were no statistically significant differences between the two groups in the numbers of people who were unable to return to their previous residence (8/43 versus 10/42) or in those with a reduction in their walking ability (22/43 versus 23/42). [Moroni 2005](#) reported that the Harris Hip Score at six months was similar in both groups (63 versus 62). In [Vossinakis 2002](#) participants of the fixator group started walking on average one day earlier than those of the SHS group (reported $P < 0.001$). [Karn 2006](#) stated that both groups had the same Harris hip score (90) and WOMAC score (3) at six months follow-up.

DISCUSSION

Summary of main results

Fixed nail plates versus the SHS

Only three small studies, all of poor methodology, were identified. Furthermore, the poor reporting of outcomes within these studies means that clear-cut conclusions regarding the difference between fixed nail plates and the SHS cannot be made from randomised trials. However within the limited data presented, there was a significantly increased risk of failure of fixation (61% versus 14%) for the fixed nail plates. In addition, there was potential for more hip pain and reduced mobility after a fixed nail plate.

The shortage of evidence from randomised trials may be because the SHS and fixed nail plate have been extensively evaluated by other methods before the more widespread use of randomised trials. Mechanical tests have consistently indicated that the fixed nail plates are weaker than the SHS and therefore more liable to break. Case series reports and comparative case series reports have also supported the conclusion that fixed nail plates have a markedly increased risk of fixation failure ([Chinoy 1999](#)).

Fixed nail plates are often marginally cheaper than the SHS. The saving in implant costs represents only a small proportion of the total cost of treating a hip fracture. Furthermore, as a consequence of the increased risk of fixation failure there is a potentially increased, but not proven in this review, risk of reoperation with

its associated costs. Reduced implant cost should not therefore be cited as justification for using a fixed nail plate.

Resistance augmented bateaux (RAB) plate versus the SHS

The two studies identified gave contrasting results with one study (Buciuto 1998) tending to favour the RAB plate, in terms of a lower fixation failure rate and improved anatomical restoration, and the other study (Lizaur Utrilla 1998) favouring the SHS in terms of intra-operative outcomes and lower fixation failure rate. It should be noted that the combined overall fixation failure rate for both implants in the two studies was 43/352 (12.2%) which is higher than that reported in other randomised trials (Parker 2010). The high fixation failure rate for the SHS was accounted for primarily by the rate of cut-out in Buciuto 1998 (10/95 (10.5%)). The overall cut-out rate for the SHS in a Cochrane review of trials comparing it with intramedullary nails (Parker 2010) was 39/1416 (2.8%). The small numbers of patients involved, lack of intention-to-treat analysis, incomplete outcome ascertainment and clear heterogeneity in the findings of these two trials means that no conclusions can be made about the relative effectiveness of these two implants.

Pugh nail versus the SHS

The one identified study of 100 cases (McLaren 1991) indicated, within the limited results presented, that there were no gross differences in any of the outcome measures between the two implants. However, it is not possible to confirm this.

Medoff sliding plate versus the SHS

The Medoff plate is a more recent innovation and to date its evaluation within randomised trials is limited. For this implant, a distinction was made between stable and unstable fractures in all trials. No cases of fixation failure for stable fractures occurred. Watson 1998 referred to the "larger surgical exposure" (resulting in increased operating time and blood loss for the Medoff plate group) as the basis for their recommendation for precluding the use of this device for stable fracture fixation. However this conclusion should be interpreted with caution due to the small numbers involved. Olsson 2001 used a smaller four-hole Medoff plate, which may account for the smaller differences noticed between implants for length of surgery and operative blood loss.

For unstable fractures there was a statistically significantly reduction in the fixation failure rate in the Medoff plate group, but this needs to be confirmed in further studies before definite conclusions can be made. It should also be noted that the overall failure rate for the SHS (17/237 (7.2%)), mainly resulting from cut-out, is higher than other randomised studies as discussed earlier.

Medoff sliding plate versus any of three screw-plate systems

Lunsjo 2001 and Lunsjo 1999 compared the Medoff plate with three other screw-plates in unstable trochanteric and in subtrochanteric fractures respectively. These studies had major limitations as the 'control' implant was one of three screw-plate systems, which could be used at the discretion of the operating surgeon. This study design means that it is not possible to conclude if the Medoff plate was superior, equivalent or inferior to any particular one of the three implants. Both studies involved a large number of surgeons in eight hospitals and it seems likely that the study design was compromised to allow for variation in practice in order to facilitate recruitment. The results of Lunsjo 2001 showed no statistically significant differences for the Medoff plate in comparison with the

screw plate systems for trochanteric fractures. For subtrochanteric fracture (Lunsjo 1999), there was a tendency to a lower fixation failure rate and reoperation rate for the Medoff plate in comparison with the three other plates. At present, all that can be said is that the Medoff plate remains potentially useful for the fixation of unstable trochanteric and of subtrochanteric fractures, but its superiority over other devices, in particular the SHS, remains to be confirmed.

Gotfried percutaneous compression plate (PCCP) versus the SHS

Only limited conclusions can be drawn from the four small studies comparing the PCCP with the SHS. Three of the trials reported intra-operative problems with the PCCP, some of which precluded its use. This indicates some particular restrictions to its use. Consistent with its less invasive method of insertion, there is some evidence of a reduced need for transfusion after surgery with the PCCP. There was no proven difference in mortality. There were insufficient data on long term functional outcomes or residual pain to make any definite conclusions.

Pertrochanteric external fixator versus the SHS

The three studies for this comparison, which involved only 200 people, found a shorter operative time, less surgical trauma, less post-operative pain, earlier mobilisation and generally a shorter hospital stay in the fixator group. Superficial (pin-track) infection was more common in the fixator group for two of the studies, although Moroni 2005 recorded no instances of superficial infection and invited consideration that this reflected the use of hydroxyapatite-coated external fixator pins; this is tested in another trial (Moroni 2004) that has been excluded from this review. Long term outcomes were poorly reported in all studies with no definite differences being apparent. While the short term results reported appear promising for the external fixator, there is insufficient evidence overall from these three small studies to draw conclusions of the relative merits of the two devices.

Overall completeness and applicability of evidence

For each comparison considered here, the limited patient numbers available at follow-up hindered the drawing of definite conclusions for key outcomes related to failure of fixation. The SHS has been to have a low overall fixation failure rate (Parker 2010). Thus to be able to determine if an implant has an equivalent or significantly lower failure rate in comparison with the SHS many more patients need to be studied. Furthermore, the included studies show a lack of consistency and other deficiencies in the reporting of outcomes. Many of the outcomes reported have been intermediate outcomes, or concerned with process. The general adoption of an agreed set of outcomes for trials comparing the effectiveness of different implant designs would be a useful development. This is particularly relevant for the functional outcomes, including residual pain and regain of mobility.

Quality of the evidence

All 18 studies were are high risk of detection bias for subjective outcomes and most studies were at high or unclear risk of other biases. Many individual studies were too small to identify important differences, or to confirm lack of differences, in outcome between the interventions under comparison.

Potential biases in the review process

We searched widely, without imposing restrictions on language or publication status, but it remains possible that we may have missed some relevant studies. These may, for instance, have been unpublished trials, raising the possibility of publication bias, or not published in journals listed in the main databases. However, our scrutiny of other reviews and articles on this topic over the years has been reassuring in that these have not identified trials of which we had not been already aware. We anticipate, however, that unpublished data from early studies, which might have augmented some comparisons, may not now be available.

AUTHORS' CONCLUSIONS

Implications for practice

The limited and methodologically flawed data available from randomised trials support the general view, based on mechanical and other clinical evaluations, that fixed nail plates have markedly higher fixation failure rates compared with the sliding hip screw (SHS). Although the evidence from randomised trials is insufficient to confirm an overall superiority of the SHS for the final outcome measures, the SHS is preferable to fixed nail plates from the results of this outcome alone.

Insufficient evidence exists to determine if the Pugh nail, the RAB plate, the Medoff plate, the Gotfried percutaneous compression plate or the pertrochanteric external fixator produce results comparable or superior to that of the SHS.

Implications for research

In spite of reservations over the data that are available, there is little to suggest that fixed nail plates should be evaluated further in well-designed trials. The Pugh nail is an early design of the SHS and it

is doubtful if further development or research on this implant is appropriate.

Further randomised trials, employing good methodology and with full reporting of outcomes, are required to determine if the other implants studied to date are inferior, equivalent to or have any advantages over the SHS. This particularly applies for the Medoff plate, PCCP plate and external fixators. Until such studies are completed, caution should be exercised in using these newer implant designs. Such trials should be sufficiently powered to be capable of demonstrating both equivalence and difference, and abide by the CONSORT criteria for design and reporting of non-pharmacological studies (Boutron 2008). Linked with other trials comparing different surgical implants for these fractures, the development of a benchmark set of outcomes, and concurrent economic evaluation are warranted (Parker 2010).

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Bannister 1990

Methods	Method of randomisation: not stated Number lost to follow-up: 5 (3%)
Participants	2 Orthopaedic hospitals in Bristol, UK 155 participants with a trochanteric (stable & unstable) extracapsular femoral fracture Mean age: 80 years (range 65 to 101 years) Percentage male: 18%
Interventions	Jewett nail plate versus sliding hip screw (AO dynamic hip screw)
Outcomes	Length of follow up: 12 months Non-union Fixation failure rate ("mechanical failure": included cut-out) Reoperation Superficial wound infection Deep wound infection Mortality (55) Pain at follow up (hip) Regain of mobility (Rehabilitation rate)
Notes	Correspondence with the trialist indicated that they were unable to provide any additional information. The information for 5 patients who were lost to follow-up and a further 55 patients who died during the study were excluded from the study. The analysis was only for the survivors. Trial was carried out in 1981, and an abstract available in 1983. Some outcomes (pain) expressed as % without denominators.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: 'randomly allocated'
Allocation concealment (selection bias)	Unclear risk	Quote: 'randomly allocated'
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding

Bannister 1990 (Continued)

Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	High risk	Five patients lost to follow-up and 55 patients died during follow-up not included in the results
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	Five patients lost to follow-up and 55 patients died during follow-up not included in the results
Selective reporting (reporting bias)	High risk	Minimal outcomes reported
Surgeons' experience with trial operations	Unclear risk	Not stated

Buciuto 1998

Methods	Method of randomisation: not stated Number lost to follow-up: 12 (5%)
Participants	Orthopaedic hospital in Linköping, Sweden 233 participants with an unstable trochanteric extracapsular femoral fracture Median (?) age: 82/80 years (range 47 to 97 years) Percentage male: 27%
Interventions	RAB-plate (Rigidity Augmentation Baixauli) versus sliding hip screw (Richards compression hip screw)
Outcomes	Length of follow up: 1 year minimum (1 to 3 years, mean 2 years) Length of surgery Operative blood loss Cut-out Non-union Fixation failure rate Reoperation Deep infection Leg shortening Varus deformity Mortality
Notes	For the 233 participants, outcomes measures other than mortality were only reported on 186 participants. Supplementary paper available on the outcome of the 20 participants who had their implant removed after fracture healing.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated
Allocation concealment (selection bias)	Unclear risk	Not stated

Buciuto 1998 (Continued)

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel used
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of participants used
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	High risk	233 patients randomised but only 186 assessed
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	Minimal follow-up data presented
Selective reporting (reporting bias)	High risk	Limited outcomes reported
Surgeons' experience with trial operations	Unclear risk	Not stated

Esser 1986

Methods	Method of randomisation: computer generated random numbers Number lost to follow-up: not stated
Participants	Orthopaedic hospital in Bangor, UK 100 participants, all female, with a trochanteric fracture (stable & unstable) Mean age: 82 years (all over 60) Percentage male: 0%
Interventions	Jewett nail plate (a fixed nail plate) versus sliding hip screw (dynamic hip screw)
Outcomes	Length of follow-up: 6 months Length of surgery Loss of fixation and cut-out rate (composite outcome: confusing data) Length of hospital stay Mortality Pain at follow up Failure to regain mobility
Notes	3 Jewett nail plate group participants had change of device: 2 excluded, 1 to a dynamic hip screw (intention-to-treat problem). Outcomes often expressed as %. Denominators deduced for analyses, based on assumption of no losses to follow-up for 98 patients. Correspondence from trialist (Dr Jones) indicated that no additional information of the study is available.

Risk of bias

Esser 1986 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "a routine for generating random digits by computer"
Allocation concealment (selection bias)	Unclear risk	Quote: "a routine for generating random digits by computer"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel used
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel used
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	High risk	Limited outcomes presented
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	Limited outcomes presented
Selective reporting (reporting bias)	High risk	Limited outcomes presented
Surgeons' experience with trial operations	Unclear risk	Not mentioned

Janzing 2002

Methods	Method of randomisation: sealed numbered envelopes Number lost to follow-up: 9 (8%)
Participants	Orthopaedic hospital in Leuven, Belgium 115 participants with a trochanteric fracture (stable & unstable) Mean age: 82.5 years Percentage male: 17%
Interventions	Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (dynamic hip screw) All participants of the SHS group had an additional stabilising screw and 17 had an additional trochanteric stabilising plate
Outcomes	Length of follow-up: 12 months Length of surgery Units of blood transfused Fall in haemoglobin Haematoma (in abstract only) Cut-out Later fracture of the femur

Janzing 2002 (Continued)

Other complications of fixation
Reoperation
Mortality
Pain in first week after surgery
Use of walking aids
Residence

Notes

One person in the PCCP group had a sliding hip screw as the fracture could not be reduced adequately by closed methods.

Abstract report and full article available for 71 participants. Different fracture classification but overlap of trial periods and clearly the same trial. Another abstract reports for 100 participants.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "drawing a sealed and numbered envelope containing the treatment modality for each patient"
Allocation concealment (selection bias)	Low risk	Quote: "drawing a sealed and numbered envelope containing the treatment modality for each patient"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	No blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	Unclear risk	Limited reporting of short term outcomes
Incomplete outcome data (attrition bias) Longer-term outcomes	Unclear risk	Nine patients lost to follow-up and a further 23 died during the follow-up period
Selective reporting (reporting bias)	Unclear risk	Limited reporting of outcomes
Surgeons' experience with trial operations	Unclear risk	Not mentioned

Karn 2006

Methods

Method of randomisation: not stated
Number lost to follow-up: not stated

Participants

Orthopaedic hospital in Dharan, Nepal
60 participants with a trochanteric extracapsular femoral fracture

Extramedullary fixation implants and external fixators for extracapsular hip fractures in adults (Review)

Karn 2006 (Continued)

Mean age: 67 years (range 50 to 100 years)

Percentage male: 50%

Interventions	Closed reduction and external fixation versus sliding hip screw
Outcomes	Length of follow up: 24 weeks Length of surgery Operative blood loss Cut-out Non-union Fixation failure rate Reoperation Wound infection Length of hospital stay Leg shortening Varus deformity Range of movement of hip and knee Harris hip score WMAC index Cost of treatment

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated
Allocation concealment (selection bias)	Unclear risk	Not stated
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	No blinding of personnel
Incomplete outcome data (attrition bias) Short-term outcomes	High risk	Limited outcomes presented and loss to follow-up not mentioned
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	Limited outcomes presented and loss to follow-up not mentioned
Selective reporting (reporting bias)	High risk	Limited outcomes presented

Karn 2006 (Continued)

Surgeons' experience with trial operations	Unclear risk	Not stated
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Kosygan 2002

Methods	Method of randomisation: sealed envelopes opened in the operating theatre Number lost-to follow up: none
Participants	Orthopaedic hospital in Harrogate, UK 111 participants with a trochanteric fracture (stable & unstable) Mean age: 83 years Percentage male: 19%
Interventions	Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (Richards hip screw)
Outcomes	Length of follow-up: 6 months Length of surgery Drainage of blood Units of blood transfused Fall in haemoglobin X-ray screening time during operation Cut-out Other complications of fixation Reoperation Superficial wound sepsis Deep wound infection Pressure infection Deep vein thrombosis Pulmonary embolism Other medical complications Length of hospital stay Limb shortening Mortality
Notes	Three participants of the PCCP group had a sliding hip screw as the fracture could not be reduced adequately by closed methods.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "choice of implant was determined at the induction of anaesthesia by opening of a sealed envelope"
Allocation concealment (selection bias)	Unclear risk	Quote: "choice of implant was determined at the induction of anaesthesia by opening of a sealed envelope"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel

Kosygan 2002 *(Continued)*

Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	Low risk	Relevant outcome reported
Incomplete outcome data (attrition bias) Longer-term outcomes	Low risk	No patients lost to follow-up and 17 died during the follow-up period
Selective reporting (reporting bias)	Low risk	Full reporting of outcomes
Surgeons' experience with trial operations	Low risk	Quote: "procedures were performed by three experienced surgeons who had been instructed in the use of the PCCP by its inventor". In addition, the first two cases were not included.

Lizaur Utrilla 1998

Methods	Method of randomisation: sequence of admission Number lost to follow-up: 8 (4%)
Participants	Orthopaedic unit in Alicante, Spain 200 participants with a trochanteric (stable & unstable) extracapsular femoral fracture Mean age: 80 years (range not stated; age 60+ years) Percentage male: 24%
Interventions	RAB-plate (Rigidity Augmentation Baixauli) versus sliding (compression) hip screw
Outcomes	Length of follow-up: 6 to 12 months (mean 10 months) Length of surgery Operative blood loss Need for transfusion Radiographic screening time Operative complications Degree of technical difficulty Operative fracture of the femur Cut-out of the implant Breakage of the implant Loosening or disassembly of the implant Non-union Avascular necrosis Reoperation Superficial wound infection Deep wound infection Mortality Urinary infection Thrombophlebitis Length of hospital stay Varus deformity Leg shortening Hip flexion External rotation Thigh or hip tenderness Time till mobilisation

Lizaur Utrilla 1998 (Continued)

Ambulation score

Notes

The results for 26 participants who died within the one year from injury and a further 8 participants who were lost to follow up were not given.

Discrepancy between text and table in the numbers of implant breakage or loosening: 4 in tables, but 5 had re-operations due to this complication.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "assigned randomly according to the sequence of admission"
Allocation concealment (selection bias)	High risk	Quote: "assigned randomly according to the sequence of admission"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	High risk	The results for a further 26 participants who died within the one year from injury and a further 8 participants who were lost to follow-up were not given.
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	The results for 26 participants who died within the one year from injury and a further 8 participants who were lost to follow up were not given.
Selective reporting (reporting bias)	Low risk	All relevant outcomes reported
Surgeons' experience with trial operations	Low risk	All operations undertaken by four surgeons with the same degree of experiences and the first 10 cases of the RAB plate were not included

Lunsjo 1999

Methods	Method of randomisation: sealed envelopes opened in the operating theatre Number lost to follow-up: 10 (9.3%)
Participants	8 Orthopaedic hospitals in Sweden 107 participants with a subtrochanteric fracture Mean age: 80 years (range 21 to 99 years) Percentage male: 20%

Lunsjo 1999 (Continued)

Interventions	Medoff sliding plate (6 hole version) versus one of three screw-plate systems (sliding hip screw: 32 cases, dynamic compression plate: 12 cases, sliding hip screw with a trochanteric stabilising plate: 8 cases) selected by operating surgeon
Outcomes	Length of follow-up: 12 months minimum Length of surgery Operative blood loss Total blood loss (operative and drains) Cut-out of the implant Non-union Later fracture of the femur Breakage of the implant Reoperation Superficial wound infection Deep wound infection Thromboembolic complications Length of hospital stay Mortality Failure to regain mobility Failure to return home
Notes	Correspondence from trialists (Dr Ceder) indicated that no additional information for the study is available. Separate results for each of the 3 screw-plate systems were reported but are not presented here for reasons given in the text.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "sealed envelopes opened just starting an attempted closed reduction"
Allocation concealment (selection bias)	Unclear risk	Quote: "sealed envelopes opened just starting an attempted closed reduction"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	Low risk	Early complications fully reported
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	Ten patients lost to follow-up and a further 16 died during the follow-up period
Selective reporting (reporting bias)	Low risk	All main relevant outcomes reported

Lunsjo 1999 (Continued)

Surgeons' experience with trial operations	High risk	Quote: "many of them [surgeons] had little, if any experience with this method (Medoff plate)"
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Lunsjo 2001

Methods	Method of randomisation: sealed envelopes opened in the operating theatre Number lost to follow-up: 48 (8.4%)
Participants	8 Orthopaedic hospitals in Sweden 569 participants with an unstable trochanteric fracture Mean age: 82 years (range 42 to 99 years) Percentage male: 27%
Interventions	Medoff sliding plate (6 hole version) versus one of three screw-plate systems (sliding hip screw: 238 cases, dynamic compression plate: 14 cases, sliding hip screw with a trochanteric stabilising plate: 49 cases) selected by operating surgeon
Outcomes	Length of follow-up: 12 months minimum Length of surgery Operative blood loss Total blood loss (operative and drains) Cut-out of the implant Non-union Breakage of the implant Reoperation Superficial wound infection Deep wound infection Thromboembolic complications Length of hospital stay Mortality Failure to regain mobility Failure to return home
Notes	Separate results for each of the three screw-plate systems were reported but are not presented here for reasons given in the text.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "sealed envelopes were opened just before the surgeon tried to perform closed reduction of the fracture"
Allocation concealment (selection bias)	Unclear risk	Quote: "sealed envelopes were opened just before the surgeon tried to perform closed reduction of the fracture"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel

Lunsjo 2001 (Continued)

Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	Low risk	Early complications fully reported
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	48 patients lost to follow-up and a further 132 died during the follow-up period
Selective reporting (reporting bias)	Unclear risk	Limited reporting of relevant outcomes reported
Surgeons' experience with trial operations	Unclear risk	Not stated

McCormack 2010

Methods	Method of randomisation: not stated Number lost to follow-up: not stated
Participants	Orthopaedic hospital in British Columbia, Canada 163 participants with an unstable trochanteric extracapsular femoral fracture Mean age: not stated (range not stated, all over 60 years) Percentage male: not stated
Interventions	Medoff sliding plate versus sliding hip screw
Outcomes	Length of follow-up: minimum 6 months Length of surgery Blood transfusion Cut-out Non-union Reoperation Functional outcome
Notes	Reported only as a conference abstract. The abstract states 163 patients were randomised but the results are presented for only 162 patients.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated
Allocation concealment (selection bias)	Unclear risk	Not stated
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel

McCormack 2010 (Continued)

Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	No blinding of personnel
Incomplete outcome data (attrition bias) Short-term outcomes	High risk	Limited outcomes presented and loss to follow-up not mentioned
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	Limited outcomes presented and loss to follow-up not mentioned
Selective reporting (reporting bias)	High risk	Limited outcomes presented
Surgeons' experience with trial operations	Unclear risk	Not stated

McLaren 1991

Methods	Randomised by even or odd patient medical record number Lost to follow-up: none
Participants	Orthopaedic hospital Dundee, UK 100 participants with an intertrochanteric (stable & unstable) femoral fractures. 49% unstable fractures. Mean age: 80 years (range 66 to 97 years) Percentage male: 19%
Interventions	Pugh nail versus sliding hip screw (dynamic hip screw)
Outcomes	Length of follow-up: 6 months minimum Length of surgery Cut-out Fixation failure rate Technical problems of surgery Unsatisfactory fixations Deep infection Deep vein thrombosis Length of hospital stay Mortality Pain at follow up Mobility

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "according to whether their unit numbers were odd or even"

McLaren 1991 (Continued)

Allocation concealment (selection bias)	High risk	Quote: "according to whether their unit numbers were odd or even"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	Unclear risk	Reporting of limited short term outcomes
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	Limited reporting of long term outcomes
Selective reporting (reporting bias)	High risk	Limited outcomes reported
Surgeons' experience with trial operations	Unclear risk	Not stated

Moroni 2005

Methods	Method of randomisation: computer generated list; treatment allocation revealed to surgeon after patient enrolment Number lost to follow-up: not stated
Participants	Orthopaedic hospital in Bologna, Italy 40 participants with a trochanteric fracture (stable & unstable) Mean age: 80 years Percentage male: 0%
Interventions	Pertrochanteric external fixator versus sliding hip screw The external fixator had hydroxyapatite coated pins and was removed after three months.
Outcomes	Length of follow-up: 6 months Length of surgery Transfusion Mean units blood transfused Cut-out rate Other complications of fixation Wound infection Length of hospital stay Harris hip score
Notes	

Moroni 2005 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "randomised by a computer-generated list". "The treatment assignment was disclosed to the surgeon after the patient was enrolled in the study"
Allocation concealment (selection bias)	Low risk	Quote: "randomised by a computer-generated list". "The treatment assignment was disclosed to the surgeon after the patient was enrolled in the study"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	Unclear risk	Limited reporting of outcomes
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	Loss to follow-up not clear
Selective reporting (reporting bias)	Unclear risk	Very limited reporting of outcomes
Surgeons' experience with trial operations	Unclear risk	Quote: "all operations were performed by one of the authors"

Olsson 2001

Methods	Method of randomisation: "the drawing of an unseen card" Number lost to follow-up: 3 excluded after randomisation, 8 were unable to attend follow-up due to poor general health
Participants	Orthopaedic hospital in Helsingborg, Sweden 114 participants with a trochanteric fracture Mean age: 84 years (range 61 to 98 years) Percentage male: 30%
Interventions	Medoff sliding plate (4 hole version) versus sliding hip screw
Outcomes	Length of follow-up: 4 months Length of surgery Operative blood loss Fall in haemoglobin Mean units blood transfused Cut-out of the implant

Olsson 2001 (Continued)

Reoperation
Wound infection
Thromboembolic complications
Length of hospital stay
Limb shortening
Mortality
Failure to regain mobility
Failure to return home

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "the drawing of an unseen card"
Allocation concealment (selection bias)	Unclear risk	Quote: "the drawing of an unseen card"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	Unclear risk	Reporting of limited short term outcomes
Incomplete outcome data (attrition bias) Longer-term outcomes	Unclear risk	Number of patients lost to follow-up not clearly stated
Selective reporting (reporting bias)	Low risk	Major outcomes reported
Surgeons' experience with trial operations	Unclear risk	Operations undertaken by 22 different surgeons

Peyser 2007

Methods	Method of randomisation: "in the operating theatre where sequentially numbered, sealed, opaque envelopes were opened by a nurse at the time of operation" Number lost to follow-up: 1 excluded from the PCCP as failure of closed reduction and a further one from the PCCP group as died in the peri-operative period, 69 patients assessed for functional recovery and 53 assessed for radiological outcome.
Participants	Orthopaedic hospital in Jerusalem, Israel

Extramedullary fixation implants and external fixators for extracapsular hip fractures in adults (Review)

Peyser 2007 (Continued)

104 participants with a trochanteric fracture
Mean age: 81 years (range 62 to 95 years)
Percentage male: 33%

Interventions	Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS)
Outcomes	Length of follow-up: 12 months Length of surgery Operative blood loss Fall in haemoglobin Mean units blood transfused Number of patients transfused Cut-out of the implant Avascular necrosis Reoperation Wound infection Pneumonia Thromboembolic complications Other medical complications Length of hospital stay Limb shortening Mortality Pain Amount of weight bearing on injured leg

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Computer generated random number series with blocking in groups of ten"
Allocation concealment (selection bias)	Low risk	Quote: "in the operating theatre where sequentially numbered, sealed, opaque envelopes were opened by a nurse at the time of operation"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Blinding of only the recording of blood loss and medical complications
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	Low risk	Outcomes reported for all but one patient in the PCCP group excluded after randomisation for failure of closed reduction
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	69 out of 104 patients assessed for functional recovery

Peyser 2007 (Continued)

Selective reporting (reporting bias)	Low risk	Relevant outcomes reported
Surgeons' experience with trial operations	Low risk	Quote: "all participating surgeons were experienced in both techniques"

Pitsaer 1993

Methods	Randomised study: method of randomisation not stated Number of lost to follow-up: 8 (8%)
Participants	Orthopaedic hospital in Winchester, UK 100 participants with an intertrochanteric (stable & unstable) proximal femoral fracture Mean age: not stated. Percentage male: not stated
Interventions	McLaughlin nail plate versus sliding hip screw (dynamic hip screw)
Outcomes	Length of follow-up: 6 months Cut-out Breakage of implant Shortening Reoperation Mortality (33) Pain Regain of mobility
Notes	Request for further information sent to both authors Analysis of survivors.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated
Allocation concealment (selection bias)	Unclear risk	Not stated
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias)	Unclear risk	Limited reporting of outcomes

Pitsaer 1993 (Continued)

Short-term outcomes

Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	Limited reporting
Selective reporting (reporting bias)	High risk	Limited reporting
Surgeons' experience with trial operations	Unclear risk	Not stated

Vossinakis 2002

Methods	Method of randomisation: sealed envelopes Number lost to follow-up: none
Participants	Orthopaedic hospital in Volos, Greece 100 participants with a trochanteric fracture (stable & unstable) Mean age: 77 years Percentage male: 26%
Interventions	Pertrochanteric external fixator versus sliding hip screw
Outcomes	Length of follow-up: 6 months Length of surgery Operative blood loss Units of blood transfused Fall in haemoglobin Cut-out rate Other complications of fixation Reoperation Superficial wound or pin-track infection Deep wound infection Length of hospital stay Limb shortening Varus deformity Mortality Pain after surgery Failure to regain mobility Time to walking Failure to return home Place of discharge from hospital Time to fracture healing

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "sealed envelopes containing cards, indicating the treatment for each patient"
Allocation concealment (selection bias)	Unclear risk	Quote: "sealed envelopes containing cards, indicating the treatment for each patient"

Vossinakis 2002 (Continued)

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	Not blinded (although this is unlikely to affect outcome)
Incomplete outcome data (attrition bias) Short-term outcomes	Low risk	No patients reported to be lost to follow-up
Incomplete outcome data (attrition bias) Longer-term outcomes	Low risk	15 patients died during the follow-up period
Selective reporting (reporting bias)	Low risk	Relevant outcomes reported
Surgeons' experience with trial operations	Unclear risk	All operations undertaken by one of four surgeons but experience not stated

Watson 1998

Methods	Method of randomised trial: not stated Loss to follow-up: 12 (7%)
Participants	Orthopaedic hospital in Detroit, USA 178 participants with 182 intertrochanteric (stable & unstable) femoral fractures Mean age: 76 years (range 25 to 99 years) Percentage male: 34% male
Interventions	Medoff sliding plate (6 hole version) versus sliding hip screw (compression hip screw: 4 hole side plate)
Outcomes	Length of follow-up: 6 months minimum (6 to 26 months, mean 9.5 months) Cut-out Non-union Implant breakage Fixation failure rate Reoperation Superficial wound infection Deep wound infection Thromboembolism Mortality Failure to regain mobility Failure to return home
Notes	

Risk of bias

Watson 1998 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "according to their medical records number"
Allocation concealment (selection bias)	High risk	Quote: "according to their medical records number"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding of participants or personnel
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding of personnel
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	No blinding of personnel
Incomplete outcome data (attrition bias) Short-term outcomes	High risk	The outcome for 12 patients lost to follow-up and 11 patients that died were not presented
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	The outcome for 12 patients lost to follow-up and 11 patients that died were not presented
Selective reporting (reporting bias)	High risk	Minimal outcomes reported
Surgeons' experience with trial operations	Unclear risk	Surgery was performed by the resident staff and supervised by one of four attending staff

Yang 2011

Methods	Method of randomisation: the randomisation order was computer generated in a 1:1 ratio on the bases of balanced blocks of ten patients. Sequentially numbered sealed envelopes containing the treatment allocation were then used. Number lost to follow-up: 14. A further 14 patients died during the follow-up period.
Participants	Orthopaedic hospital in Ney York, USA 66 participants with a trochanteric fracture Mean age: 77/76 years (range not given) Percentage male: 29%
Interventions	Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS)
Outcomes	Length of follow-up: 12 months (but mean 10 / 9 months in supplementary data table) Length of surgery Operative blood loss Length of incision Mean units blood transfused Number of patients transfused Cut-out of the implant

Yang 2011 (Continued)

Fracture healing complications
Mortality
Pain
Loss of functional status
Use of assistive walking at two weeks after surgery

Notes Extra information provided by lead author include details that no fracture healing complications occurred

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "computer generated in a 1:1 ratio on the bases of balanced blocks of ten patients"
Allocation concealment (selection bias)	Low risk	Quote: "Sequentially numbered sealed opaque envelopes which defined the treatment assignment were opened as the subjects were enrolled"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding
Blinding of outcome assessment (detection bias) Subjective outcomes	High risk	No blinding
Blinding of outcome assessment (detection bias) Objectives outcomes	Unclear risk	No blinding
Incomplete outcome data (attrition bias) Short-term outcomes	Unclear risk	All patients included in short term operative outcomes
Incomplete outcome data (attrition bias) Longer-term outcomes	High risk	14 patients lost to follow-up and a further 14 died during the follow-up period
Selective reporting (reporting bias)	Unclear risk	Limited outcomes reported
Surgeons' experience with trial operations	Unclear risk	Quote: "Surgery by one of seven attending surgeons and/or residents with direct supervision by an attending surgeon". Experiences of surgeons not stated

FNP: fixed nail plate

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Enskog 1999	This study was reported only as a conference abstract which gave preliminary results for 41 participants of an ongoing randomised study. The study compared a sliding hip screw versus a similar device in which the lag screw was replaced by two Olmed screws. The follow-up of 27 cases showed

Study	Reason for exclusion
	no notable differences between implants. No further reports of this study have been forthcoming and the study was therefore excluded due to lack of presented information.
Heyse-Moore 1983	Non-randomised retrospective comparison of the Jewett nail plate with the sliding hip screw. An original randomised trial was abandoned because it was seen that the dynamic hip screw was superior. Correspondence with the authors revealed that no information on patient numbers and no results are available for the abandoned randomised trial.
Kumar 2006	This study was reported as a conference abstract of a randomised trial, involving 50 patients with unstable trochanteric fractures, comparing the sliding hip screw versus the same implant supplemented with a trochanteric stabilising plate. The abstract reported that the operative blood loss and length of surgery were increased for those treated with the supplementary stabilising plate although the difference was not statistically significant. The functional outcome, limb length discrepancy and abductor muscle strength were all reported to be statistically significantly better for those treated with the stabilising plate. There were three cases of cut-out in the SHS group and none in the stabilising plate group. We were unable to contact the trial authors for this trial. The study was excluded because there was insufficient reporting of the study details and the patient numbers were not given for each group.
Lahav 2007	This study of 142 patients compared the Dynamic Hip Screw with the Percutaneous Compression Plate. The study was only reported as a conference abstract and was excluded as there was no mention of randomisation of patients.
Laufer 2005	Non-randomised comparison of the dynamic hip screw (routinely used in two hospitals) versus the percutaneous compression plate (routinely used in one hospital).
Li 2010	The English abstract of this trial otherwise reported in Chinese describes a study of 48 patients with a trochanteric hip fracture in which treatment was "randomly assigned" between a sliding hip screw or an anatomic plate. However, perusal of the text by a Chinese speaking doctor found no reference to randomisation and there was no response to an email request to the authors for clarification on trial methodology. It thus seems very unlikely that this was actually a randomised trial.
Moroni 2004	This study of 120 participants compared a standard sliding hip screw with one in which the lag screw was coated in hydroxyapatite. This comparison does not fall in the scope of this review.
Olsson 2000	This study was a comparison of extracapsular proximal femoral fractures treated with either a sliding hip screw or a twin hook modification of the sliding hip screw. It was excluded because it was not a randomised study.
Ouyang 2010	The English abstract of this trial otherwise reported in Chinese describes a study of 92 patients with an upper femoral shaft fracture in which patients were "randomly divided" into three groups using an interlocking intramedullary nail, compression plate or Plum nail. This does not appear to be a comparison of extramedullary fixation implants. Moreover, a translation of the Methods showed this to be described as a "retrospective study", where "92 subjects were randomly allocated into 3 groups based on their preferences". Thus this was not a randomised trial.
Peyser 2005	This was a retrospective comparison of 155 patients treated with either a sliding hip screw or a percutaneous compression plate. The study was excluded as there was no randomisation of patients.
Raunest 1995	In this study, 93 stable trochanteric fractures were treated with a sliding hip screw, 44 unstable trochanteric fractures were treated with a sliding hip screw and 42 unstable trochanteric fractures were treated with a 95 degree blade plate. The study was excluded because there was no randomisation of patients to the different implants.
Romero 2008	This was a study of 26 patients with a trochanteric hip fracture: 13 were treated with a percutaneous compression plate (PCCP) and 13 with a dynamic hip screw. Those patients treated with the

Study	Reason for exclusion
	PCCP were found to have a lower surgical time and a reduced need for blood transfusion. The study was excluded as it was a comparative study with no randomisation of patients.
Weisbrot 2005	This study was reported only as a conference abstract as a randomised study involving 110 patients treated with either the Percutaneous Compression Plate (PCCP) or the sliding hip screw. There was a tendency to fewer complications with the PCCP (15% versus 22%). The exact number and nature of these complications was not given in the conference abstract. The study was excluded as there was a lack of information presented within the conference abstract, which additionally gave no contact address or email.
Zhen 2010	The English abstract of this trial otherwise reported in Chinese describes a study of 57 patients with a trochanteric hip fracture who were "randomly divided" to fixation into two groups with either a trapezoid compression plate (21 patients) or an anatomic plate (36 patients). These patients re-recruited over nine years were followed up between 5 months and 9 years and 3 months. The imbalance in numbers and variation in length of follow-up raises questions about the trial methodology. There was no response to an email request to the authors for clarification on trial methodology but it is very unlikely that this was actually a randomised trial.

Characteristics of studies awaiting assessment [ordered by study ID]

ChiCTR 2011

Methods	"Randomized parallel trial"
Participants	75 patients with an intertrochanteric fracture, aged 60+ years, with independent ambulation before their fracture
Interventions	Minimally invasive percutaneous compression plating versus dynamic hip screw
Outcomes	Blood loss, postoperative complications, VAS score, Harris hip score
Notes	The trial, conducted Oct 2007 to Feb 2010 was retrospectively registered on 27.10.2011

DATA AND ANALYSES

Comparison 1. Fixed nail plate versus sliding hip screw (SHS)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Fracture fixation complications	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
1.1 Cut-out	1	59	Risk Ratio (M-H, Fixed, 95% CI)	0.63 [0.13, 3.20]
1.2 Non-union	1	86	Risk Ratio (M-H, Fixed, 95% CI)	2.78 [0.26, 29.48]
1.3 Implant breakage	1	59	Risk Ratio (M-H, Fixed, 95% CI)	28.96 [1.79, 469.66]
1.4 Fixation failure rate	2	145	Risk Ratio (M-H, Fixed, 95% CI)	4.27 [2.44, 7.45]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.5 Reoperation	2	145	Risk Ratio (M-H, Fixed, 95% CI)	1.97 [0.59, 6.58]
2 Final outcome measures	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2.1 Mortality	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2.2 Pain at follow up	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2.3 Impaired mobility	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 1.1. Comparison 1 Fixed nail plate versus sliding hip screw (SHS), Outcome 1 Fracture fixation complications.

Analysis 1.2. Comparison 1 Fixed nail plate versus sliding hip screw (SHS), Outcome 2 Final outcome measures.

Comparison 2. RAB plate versus sliding hip screw (SHS)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Number of patients transfused	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Fracture fixation complications	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
2.1 Operative complications	1	166	Risk Ratio (M-H, Fixed, 95% CI)	9.22 [0.50, 168.52]
2.2 Breakage or disassembly of the implant	1	166	Risk Ratio (M-H, Fixed, 95% CI)	9.22 [0.50, 168.52]
2.3 Cut-out	2	352	Risk Ratio (M-H, Fixed, 95% CI)	0.57 [0.22, 1.49]
2.4 Non-union	2	352	Risk Ratio (M-H, Fixed, 95% CI)	1.04 [0.24, 4.53]
2.5 Avascular necrosis	1	166	Risk Ratio (M-H, Fixed, 95% CI)	0.34 [0.01, 8.26]
2.6 Fracture below the implant	1	166	Risk Ratio (M-H, Fixed, 95% CI)	3.07 [0.13, 74.34]
2.7 Fixation failure rate	2	352	Risk Ratio (M-H, Fixed, 95% CI)	0.99 [0.56, 1.74]
2.8 Reoperation	2	352	Risk Ratio (M-H, Fixed, 95% CI)	0.84 [0.49, 1.43]
3 Wound infection	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
3.1 Superficial wound infection	1	166	Risk Ratio (M-H, Fixed, 95% CI)	1.02 [0.15, 7.10]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.2 Deep infection	2	352	Risk Ratio (M-H, Fixed, 95% CI)	0.77 [0.18, 3.41]
4 Thromboembolism	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Anatomical deformity	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
5.1 Varus deformity	2	352	Risk Ratio (M-H, Fixed, 95% CI)	0.62 [0.23, 1.67]
5.2 Leg shortening	1	186	Risk Ratio (M-H, Fixed, 95% CI)	0.14 [0.03, 0.59]
6 Mortality	2	433	Risk Ratio (M-H, Fixed, 95% CI)	0.73 [0.46, 1.18]

Analysis 2.1. Comparison 2 RAB plate versus sliding hip screw (SHS), Outcome 1 Number of patients transfused.

Study or subgroup	RAB plate n/N	SHS n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
Lizaur Utrilla 1998	46/82	33/84		1.43 [1.03, 1.98]
Favours RAB plate 0.1 0.2 0.5 1 2 5 10 Favours SHS				

Analysis 2.2. Comparison 2 RAB plate versus sliding hip screw (SHS), Outcome 2 Fracture fixation complications.

Study or subgroup	RAB plate n/N	SHS n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
2.2.1 Operative complications					
Lizaur Utrilla 1998	4/82	0/84		100%	9.22 [0.5, 168.52]
Subtotal (95% CI)	82	84		100%	9.22 [0.5, 168.52]
Total events: 4 (RAB plate), 0 (SHS)					
Heterogeneity: Not applicable					
Test for overall effect: Z=1.5 (P=0.13)					
2.2.2 Breakage or disassembly of the implant					
Lizaur Utrilla 1998	4/82	0/84		100%	9.22 [0.5, 168.52]
Subtotal (95% CI)	82	84		100%	9.22 [0.5, 168.52]
Total events: 4 (RAB plate), 0 (SHS)					
Heterogeneity: Not applicable					
Test for overall effect: Z=1.5 (P=0.13)					
2.2.3 Cut-out					
Buciuto 1998	5/91	10/95		90.83%	0.52 [0.19, 1.47]
Lizaur Utrilla 1998	1/82	1/84		9.17%	1.02 [0.07, 16.11]
Subtotal (95% CI)	173	179		100%	0.57 [0.22, 1.49]
Total events: 6 (RAB plate), 11 (SHS)					
Heterogeneity: Tau ² =0; Chi ² =0.2, df=1 (P=0.65); I ² =0%					
Test for overall effect: Z=1.15 (P=0.25)					
Favours RAB plate 0.001 0.1 1 10 1000 Favours SHS

Analysis 2.3. Comparison 2 RAB plate versus sliding hip screw (SHS), Outcome 3 Wound infection.

Analysis 2.4. Comparison 2 RAB plate versus sliding hip screw (SHS), Outcome 4 Thromboembolism.

Analysis 2.5. Comparison 2 RAB plate versus sliding hip screw (SHS), Outcome 5 Anatomical deformity.

Analysis 2.6. Comparison 2 RAB plate versus sliding hip screw (SHS), Outcome 6 Mortality.

Comparison 3. Pugh nail versus sliding hip screw (SHS)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Fixation failure	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Deep infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 Deep vein thrombosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Final outcome measures	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4.1 Mortality	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
4.2 Pain at follow up (severe or moderate)	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 3.1. Comparison 3 Pugh nail versus sliding hip screw (SHS), Outcome 1 Fixation failure.

Analysis 3.2. Comparison 3 Pugh nail versus sliding hip screw (SHS), Outcome 2 Deep infection.

Analysis 3.3. Comparison 3 Pugh nail versus sliding hip screw (SHS), Outcome 3 Deep vein thrombosis.

Analysis 3.4. Comparison 3 Pugh nail versus sliding hip screw (SHS), Outcome 4 Final outcome measures.

Comparison 4. Medoff sliding plate versus sliding hip screw (SHS)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Cut-out	3	436	Risk Ratio (M-H, Fixed, 95% CI)	0.24 [0.07, 0.82]
2 Detachment of the plate from the femur	3	436	Risk Ratio (M-H, Fixed, 95% CI)	0.19 [0.01, 3.58]
3 Non-union of fracture	3	436	Risk Ratio (M-H, Fixed, 95% CI)	5.65 [0.28, 115.86]
4 Fixation failure rate	3	436	Risk Ratio (M-H, Fixed, 95% CI)	0.30 [0.11, 0.81]
4.1 Stable trochanteric fractures	2	58	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
4.2 Unstable trochanteric fractures	3	378	Risk Ratio (M-H, Fixed, 95% CI)	0.30 [0.11, 0.81]
5 Reoperation	2	276	Risk Ratio (M-H, Fixed, 95% CI)	0.51 [0.12, 2.23]
6 Thromboembolic complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7 Final outcome measures	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
7.1 Mortality	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
7.2 Failure to return to living at own home	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
7.3 Failure to regain independent mobility	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 4.1. Comparison 4 Medoff sliding plate versus sliding hip screw (SHS), Outcome 1 Cut-out.

Analysis 4.2. Comparison 4 Medoff sliding plate versus sliding hip screw (SHS), Outcome 2 Detachment of the plate from the femur.

Analysis 4.3. Comparison 4 Medoff sliding plate versus sliding hip screw (SHS), Outcome 3 Non-union of fracture.

Analysis 4.4. Comparison 4 Medoff sliding plate versus sliding hip screw (SHS), Outcome 4 Fixation failure rate.

Analysis 4.5. Comparison 4 Medoff sliding plate versus sliding hip screw (SHS), Outcome 5 Reoperation.

Analysis 4.6. Comparison 4 Medoff sliding plate versus sliding hip screw (SHS), Outcome 6 Thromboembolic complications.

Analysis 4.7. Comparison 4 Medoff sliding plate versus sliding hip screw (SHS), Outcome 7 Final outcome measures.

Comparison 5. Medoff sliding plate versus any of three other screw-plate systems

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Cut-out	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Non-union	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
3 Implant breakage or disassembly	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
3.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
4 Fixation failure	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
4.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
5 Reoperation	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
5.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
6 Superficial wound infection	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
6.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
7 Deep wound infection	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
7.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8 Thromboembolic complications	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
8.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
8.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
9 Mortality (1 year)	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
9.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
9.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
10 Failure to return home	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
10.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
11 Failure to regain mobility	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
11.1 Unstable trochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
11.2 Subtrochanteric fractures	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 5.1. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 1 Cut-out.

Study or subgroup	Medoff sliding plate n/N	Other screw-plate n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
5.1.1 Unstable trochanteric fractures				
Lunsjo 2001	15/268	8/301		2.11[0.91,4.89]
5.1.2 Subtrochanteric fractures				
Lunsjo 1999	0/55	4/52		0.11[0.01,1.91]
			Favours Medoff plate	Favours other plate

Analysis 5.2. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 2 Non-union.

Analysis 5.3. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 3 Implant breakage or disassembly.

Analysis 5.4. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 4 Fixation failure.

Analysis 5.5. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 5 Reoperation.

Analysis 5.6. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 6 Superficial wound infection.

Analysis 5.7. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 7 Deep wound infection.

Analysis 5.8. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 8 Thromboembolic complications.

Analysis 5.9. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 9 Mortality (1 year).

Analysis 5.10. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 10 Failure to return home.

Analysis 5.11. Comparison 5 Medoff sliding plate versus any of three other screw-plate systems, Outcome 11 Failure to regain mobility.

Comparison 6. Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Length of surgery (minutes)	3		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
2 Intraoperative blood loss (ml)	3	277	Mean Difference (IV, Random, 95% CI)	-50.00 [-103.25, 3.24]
3 Mean fall in haemoglobin (%)	2	211	Mean Difference (IV, Fixed, 95% CI)	-0.24 [-0.60, 0.11]
4 Mean units of blood transfused	4	360	Mean Difference (IV, Fixed, 95% CI)	-0.23 [-0.43, -0.03]
5 Number of patients transfused	2	169	Risk Ratio (M-H, Fixed, 95% CI)	0.81 [0.65, 1.02]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6 X-ray screening time (seconds) (approximate SDs)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
7 Fracture fixation complications	4		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
7.1 Cut-out	4	395	Risk Ratio (M-H, Fixed, 95% CI)	1.30 [0.41, 4.13]
7.2 Avascular necrosis	1	103	Risk Ratio (M-H, Fixed, 95% CI)	3.18 [0.13, 76.20]
7.3 Persistent pain requiring implant removal	1	103	Risk Ratio (M-H, Fixed, 95% CI)	3.18 [0.13, 76.20]
7.4 All fracture healing complications	4	392	Risk Ratio (M-H, Fixed, 95% CI)	1.43 [0.51, 4.00]
7.5 Reoperation	3	329	Risk Ratio (M-H, Fixed, 95% CI)	1.75 [0.59, 5.22]
8 Wound infection	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
8.1 Superficial wound infection	2	214	Risk Ratio (M-H, Fixed, 95% CI)	0.35 [0.04, 3.27]
8.2 Deep infection	2	214	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
9 Post-operative complications	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
9.1 Pneumonia	2	214	Risk Ratio (M-H, Fixed, 95% CI)	0.73 [0.33, 1.60]
9.2 Pressure sores	1	111	Risk Ratio (M-H, Fixed, 95% CI)	0.51 [0.05, 5.45]
9.3 Deep vein thrombosis	2	214	Risk Ratio (M-H, Fixed, 95% CI)	0.35 [0.09, 1.41]
9.4 Pulmonary embolism	2	214	Risk Ratio (M-H, Fixed, 95% CI)	0.52 [0.10, 2.78]
9.5 Cardiac complications	1	111	Risk Ratio (M-H, Fixed, 95% CI)	0.17 [0.02, 1.36]
9.6 Cerebrovascular accident	1	103	Risk Ratio (M-H, Fixed, 95% CI)	0.12 [0.01, 2.13]
9.7 Gastrointestinal complications	1	103	Risk Ratio (M-H, Fixed, 95% CI)	1.41 [0.33, 6.00]
9.8 Renal complications	1	100	Risk Ratio (M-H, Fixed, 95% CI)	0.86 [0.31, 2.37]
10 Length of hospital stay (days)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
11 Final outcome measures	4		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
11.1 Mortality	4	395	Risk Ratio (M-H, Fixed, 95% CI)	0.75 [0.49, 1.14]
11.2 Loss of independent mobility	1	83	Risk Ratio (M-H, Fixed, 95% CI)	1.13 [0.50, 2.55]
11.3 Loss of independence	1	83	Risk Ratio (M-H, Fixed, 95% CI)	0.13 [0.01, 2.25]

Analysis 6.1. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 1 Length of surgery (minutes).

Analysis 6.2. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 2 Intraoperative blood loss (ml).

Analysis 6.3. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 3 Mean fall in haemoglobin (%).

Analysis 6.4. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 4 Mean units of blood transfused.

Analysis 6.5. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 5 Number of patients transfused.

Analysis 6.6. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 6 X-ray screening time (seconds) (approximate SDs).

Analysis 6.7. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 7 Fracture fixation complications.

Analysis 6.8. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 8 Wound infection.

Study or subgroup	Percuta- neous plate n/N	Sliding hip screw n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Peyser 2007	0/50	0/53			Not estimable
Subtotal (95% CI)	105	109			Not estimable
Total events: 0 (Percutaneous plate), 0 (Sliding hip screw)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					
<div style="display: flex; justify-content: space-between;"> Favours PCCP 0.01 0.1 1 10 100 Favours SHS </div>					

Analysis 6.9. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 9 Post-operative complications.

Study or subgroup	Percuta- neous plate n/N	Sliding hip screw n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
6.9.1 Pneumonia					
Kosygan 2002	1/55	4/56		31.21%	0.25[0.03,2.21]
Peyser 2007	8/50	9/53		68.79%	0.94[0.39,2.25]
Subtotal (95% CI)	105	109		100%	0.73[0.33,1.6]
Total events: 9 (Percutaneous plate), 13 (Sliding hip screw)					
Heterogeneity: Tau ² =0; Chi ² =1.25, df=1(P=0.26); I ² =19.83%					
Test for overall effect: Z=0.79(P=0.43)					
6.9.2 Pressure sores					
Kosygan 2002	1/55	2/56		100%	0.51[0.05,5.45]
Subtotal (95% CI)	55	56		100%	0.51[0.05,5.45]
Total events: 1 (Percutaneous plate), 2 (Sliding hip screw)					
Heterogeneity: Not applicable					
Test for overall effect: Z=0.56(P=0.58)					
6.9.3 Deep vein thrombosis					
Kosygan 2002	0/55	1/56		20.33%	0.34[0.01,8.15]
Peyser 2007	2/50	6/53		79.67%	0.35[0.07,1.67]
Subtotal (95% CI)	105	109		100%	0.35[0.09,1.41]
Total events: 2 (Percutaneous plate), 7 (Sliding hip screw)					
Heterogeneity: Tau ² =0; Chi ² =0, df=1(P=0.98); I ² =0%					
Test for overall effect: Z=1.47(P=0.14)					
6.9.4 Pulmonary embolism					
Kosygan 2002	1/55	2/56		50.51%	0.51[0.05,5.45]
Peyser 2007	1/50	2/53		49.49%	0.53[0.05,5.66]
Subtotal (95% CI)	105	109		100%	0.52[0.1,2.78]
Total events: 2 (Percutaneous plate), 4 (Sliding hip screw)					
Heterogeneity: Tau ² =0; Chi ² =0, df=1(P=0.98); I ² =0%					
Test for overall effect: Z=0.77(P=0.44)					
6.9.5 Cardiac complications					
Kosygan 2002	1/55	6/56		100%	0.17[0.02,1.36]
Subtotal (95% CI)	55	56		100%	0.17[0.02,1.36]
Total events: 1 (Percutaneous plate), 6 (Sliding hip screw)					
Heterogeneity: Not applicable					
<div style="display: flex; justify-content: space-between;"> Favours PCCP 0.01 0.1 1 10 100 Favours SHS </div>

Analysis 6.10. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 10 Length of hospital stay (days).

Study or subgroup	Percutaneous plate		Sliding hip screw		Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
	N	Mean(SD)	N	Mean(SD)		
Kosygan 2002	52	23.8 (25.7)	56	21.7 (16.3)		2.1[-6.09,10.29]
Favours PCCP -100 -50 0 50 100 Favours SHS						

Analysis 6.11. Comparison 6 Gotfried percutaneous compression plate (PCCP) versus sliding hip screw (SHS), Outcome 11 Final outcome measures.

Comparison 7. Pertrochanteric external fixator versus sliding hip screw (SHS)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Length of surgery (minutes)	2		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
2 Operative blood loss (ml)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3 Fall in haemoglobin (mg/dl)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4 Number of patients transfused	2	140	Risk Ratio (M-H, Fixed, 95% CI)	0.04 [0.01, 0.22]
5 Fracture fixation complications	3		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
5.1 Cut-out	3	200	Risk Ratio (M-H, Fixed, 95% CI)	0.54 [0.15, 1.89]
5.2 All technical complications of fracture healing	3	200	Risk Ratio (M-H, Fixed, 95% CI)	0.67 [0.20, 2.26]
5.3 Re-operation (except procedures under local or no anaesthesia)	2	160	Risk Ratio (M-H, Fixed, 95% CI)	0.14 [0.02, 1.14]
6 Wound infection	3		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
6.1 Superficial infection	3	200	Risk Ratio (M-H, Fixed, 95% CI)	8.25 [3.05, 22.31]
6.2 Deep wound infection	1	100	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.01, 7.99]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
7 Length of hospital stay (days)	2		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
8 Final outcome measures	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
8.1 Mortality (6 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
8.2 Failure to return to same residential status (survivors)	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
8.3 Reduced walking ability (survivors)	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 7.1. Comparison 7 Pertrochanteric external fixator versus sliding hip screw (SHS), Outcome 1 Length of surgery (minutes).

Study or subgroup	External fixator		Sliding hip screw		Mean Difference	
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI	Mean Difference Fixed, 95% CI
Moroni 2005	20	34 (5)	20	64 (6)	+	-30[-33.42,-26.58]
Vossinakis 2002	50	21.2 (3.9)	50	38.8 (7.5)	+	-17.6[-19.94,-15.26]

Favours fixator -50 -25 0 25 50 Favours SHS

Analysis 7.2. Comparison 7 Pertrochanteric external fixator versus sliding hip screw (SHS), Outcome 2 Operative blood loss (ml).

Study or subgroup	External fixator		Sliding hip screw		Mean Difference	
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI	Mean Difference Fixed, 95% CI
Vossinakis 2002	50	0 (0)	50	568 (174)		Not estimable

Favours fixator -10 -5 0 5 10 Favours SHS

Analysis 7.3. Comparison 7 Pertrochanteric external fixator versus sliding hip screw (SHS), Outcome 3 Fall in haemoglobin (mg/dl).

Study or subgroup	External fixator		Sliding hip screw		Mean Difference	
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI	Mean Difference Fixed, 95% CI
Vossinakis 2002	50	0.1 (0.4)	50	1.5 (0.4)	+	-1.4[-1.56,-1.24]

Favours fixator -4 -2 0 2 4 Favours SHS

Analysis 7.4. Comparison 7 Pertrochanteric external fixator versus sliding hip screw (SHS), Outcome 4 Number of patients transfused.

Analysis 7.5. Comparison 7 Pertrochanteric external fixator versus sliding hip screw (SHS), Outcome 5 Fracture fixation complications.

Analysis 7.6. Comparison 7 Pertrochanteric external fixator versus sliding hip screw (SHS), Outcome 6 Wound infection.

Analysis 7.7. Comparison 7 Pertrochanteric external fixator versus sliding hip screw (SHS), Outcome 7 Length of hospital stay (days).

Analysis 7.8. Comparison 7 Pertrochanteric external fixator versus sliding hip screw (SHS), Outcome 8 Final outcome measures.

APPENDICES

Appendix 1. Current search strategies

The Cochrane Library (Wiley Online Library, 2011 Issue 2)

- #1 MeSH descriptor Hip Fractures explode all trees (972)
- #2 ((hip* or femur* or femoral* or trochant* or pertrochant* or intertrochant* or subtrochant* or extracapsular*) NEAR/4 fracture*):ti,ab,kw (2074)
- #3 (#1 OR #2) (2074)
- #4 (pin or pins or pinned or pinning or nail* or screw* or plate* or plating or fix* or implant*):ti,ab,kw (33308)
- #5 MeSH descriptor Fracture Fixation, this term only (261)
- #6 MeSH descriptor Bone Nails, this term only (267)
- #7 MeSH descriptor Bone Plates, this term only (236)
- #8 MeSH descriptor Bone Screws, this term only (424)
- #9 MeSH descriptor External Fixators, this term only (117)
- #10 (#4 OR #5 OR #6 OR #7 OR #8 OR #9) (33308)
- #11 (#3 AND #10) (630)
- #12 SR-MUSKINJ (7005)
- #13 (#11 AND NOT #12) (242)
- #14 (#11 AND NOT #12) (166)

Footnote: Lines #12 and #13 filter out records already present in the BJMT Group's Specialised Register.

MEDLINE (OVID Online) (September 2005 to July 2011)

- 1 exp Hip Fractures/ (14982)
- 2 ((hip\$ or femur\$ or femoral\$ or trochant\$ or pertrochant\$ or intertrochant\$ or subtrochant\$ or extracapsular\$) adj4 fracture\$).tw. (21670)
- 3 or/1-2 (25587)
- 4 (pin\$1 or pinning or nail\$ or screw\$1 or plate\$1 or plating or fix\$ or implant\$).tw. (539339)
- 5 Fracture Fixation/ or Bone Nails/ or Bone Plates/ or Bone Screws/ or External Fixators/ (43194)
- 6 or/4-5 (554363)
- 7 and/3,6 (9162)
- 8 Randomized controlled trial.pt. (309463)
- 9 Controlled clinical trial.pt. (82674)
- 10 randomized.ab. (215844)
- 11 placebo.ab. (125637)
- 12 Clinical Trials as Topic/ (154910)
- 13 randomly.ab. (156203)
- 14 trial.ti. (92387)
- 15 8 or 9 or 10 or 11 or 12 or 13 or 14 (718879)
- 16 exp Animals/ not Humans/ (3604529)
- 17 15 not 16 (663527)
- 18 and/7,17 (479)
- 19 (200509* or 200510* or 200511* or 200512* or 2006* or 2007* or 2008* or 2009* or 2010* or 2011*).ed. (4202060)
- 20 18 and 19 (154)

EMBASE (OVID Online) (September 2005 to July 2011)

- 1 exp Hip Fracture/ (21965)
- 2 ((hip\$ or femur\$ or femoral\$ or trochant\$ or pertrochant\$ or intertrochant\$ or subtrochant\$ or extracapsular\$) adj4 fracture\$).tw. (25757)
- 3 or/1-2 (33284)
- 4 (pin\$1 or pinning or nail\$ or screw\$1 or plate\$1 or plating or fix\$ or implant\$).tw. (617246)
- 5 exp Fracture Fixation/ or Bone Nail/ or Bone Plate/ or Bone Screw/ or External Fixator/ or Fixation Device/ (67358)
- 6 or/4-5 (642932)
- 7 and/3,6 (12221)
- 8 Randomized Controlled Trial/ (281525)
- 9 Clinical Trial/ (810119)
- 10 Controlled Clinical Trial/ (166417)
- 11 Randomization/ (53120)
- 12 Single Blind Procedure/ (13645)
- 13 Double Blind Procedure/ (98872)

- 14 Crossover Procedure/ (29892)
- 15 Placebo/ (179752)
- 16 Prospective Study/ (164535)
- 17 ((clinical or controlled or comparative or placebo or prospective\$ or randomi#ed) adj3 (trial or study)).tw. (542762)
- 18 (random\$ adj7 (allocat\$ or allot\$ or assign\$ or basis\$ or divid\$ or order\$)).tw. (131353)
- 19 ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj7 (blind\$ or mask\$)).tw. (129475)
- 20 (cross?over\$ or (cross adj1 over\$)).tw. (55248)
- 21 ((allocat\$ or allot\$ or assign\$ or divid\$) adj3 (condition\$ or experiment\$ or intervention\$ or treatment\$ or therap\$ or control\$ or group\$)).tw. (162669)
- 22 RCT.tw. (7028)
- 23 or/8-22 (1490832)
- 24 Case Study/ or Abstract Report/ or Letter/ (793761)
- 25 23 not 24 (1457647)
- 26 and/7,25 (1542)
- 27 (2005* or 2006* or 2007* or 2008* or 2009* or 2010* or 2011*).em. (5766907)
- 28 26 and 27 (693)

WHO International Clinical Trials Registry Platform

Search (3 January 2013) resulting in 286 items (270 trials) was: (hip or proximal or extracapsular or intertrochanteric or subtrochanteric) and fracture

Appendix 2. Previous search strategies

MEDLINE (OVID) (1966 to September 2005)

1. exp Hip Fractures/
2. hip\$ or femur\$ or femoral\$ or trochant\$ or pertrochant\$ or intertrochant\$ or subtrochant\$ or intracapsular\$ or extracapsular\$) adj4 fracture\$).tw.
3. or/1-2
4. (pin\$1 or nail\$ or screw\$1 or plate\$1 or arthroplast\$ or fix\$ or prosthes\$).tw.
5. Internal Fixators/ or Bone Screws/ or Fracture Fixation, Internal/ or Bone Plates/ or Bone Nails/
6. Arthroplasty/ or Arthroplasty, Replacement, Hip/
7. or/4-6
8. and/3,7

EMBASE (OVID) (1988 to September 2005)

1. exp Hip Fracture/
2. ((hip\$ or ((femur\$ or femoral\$) adj3 (neck or proximal))) adj4 fracture\$).tw.
3. or/1-2
4. exp Randomized Controlled trial/
5. exp Double Blind Procedure/
6. exp Single Blind Procedure/
7. exp Crossover Procedure/
8. Controlled Study/
9. or/4-8
10. ((clinical or controlled or comparative or placebo or prospective\$ or randomi#ed) adj3 (trial or study)).tw.
11. (random\$ adj7 (allocat\$ or allot\$ or assign\$ or basis\$ or divid\$ or order\$)).tw.
12. ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj7 (blind\$ or mask\$)).tw.
13. (cross?over\$ or (cross adj1 over\$)).tw.
14. ((allocat\$ or allot\$ or assign\$ or divid\$) adj3 (condition\$ or experiment\$ or intervention\$ or treatment\$ or therap\$ or control\$ or group\$)).tw.
15. or/10-14
16. or/9,15
17. limit 16 to human
18. and/3,17

WHAT'S NEW

Date	Event	Description
17 January 2013	New citation required but conclusions have not changed	1. There has been a change to the authorship.
17 January 2013	New search has been performed	For the sixth substantive update, which first appeared in Issue 2, 2013, the main changes were as follows: 1. The search for trials was updated to June 2011. 2. Risk of bias was assessed. 3. There were four newly identified trials (Karn 2006 ; McCormack 2010 ; Peyser 2007 ; Yang 2011) included in the review. 4. Seven newly identified studies (Kumar 2006 ; Lahav 2007 ; Li 2010 ; Ouyang 2010 ; Romero 2008 ; Weisbrot 2005 ; Zhen 2010) were excluded, and one (ChiCTR 2011) awaits classification. 5. The Discussion was restructured and revised.

HISTORY

Protocol first published: Issue 1, 1997

Review first published: Issue 4, 1998

Date	Event	Description
19 September 2008	Amended	Converted to new review format.
7 November 2005	New search has been performed	Fifth substantive update, published in Issue 1, 2006, involved: 1. Trial search updated to July 2005; 2. New study of Moroni 2005 comparing an external fixator versus the sliding hip screw is included; 3. Extra references to studies of Kosygan 2002 and Vossinakis 2002 added; 4. Reconsideration and clarification of the outcome of fracture fixation complications resulted in changes to the comparison of the Gotfried percutaneous compression plate (PCCP) versus sliding hip screw; 5. Study of Enskog 1999 moved from 'Awaiting assessment' to 'Excluded'; 6. Two newly identified studies (Laufer 2005, Moroni 2004) were excluded; 7. 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 the I-squared statistic were made to comply with the Cochrane Handbook for Systematic Reviews of Interventions (March 2005); 8. Graphical presentation of the results was revised and compressed to reduce the number of graphs; 9. The 'Synopsis' was expanded to a 'Plain Language Summary'; 10. There were no substantial changes made to the conclusions.
11 November 2002	New search has been performed	Fourth substantive update, published in Issue 4, 2002 involved: Scope of review extended to include external fixators. This was reflected in changes to the review title. Trial search updated to July 2002. Three new studies were included: Kosygan 2002 and Janzing 2002 on the Gotfried percutaneous compression plate versus the sliding hip screw, and Vossinakis 2002 on an external fixator versus the sliding hip screw. One new study was excluded:

Date	Event	Description
		Raunest 1995. No changes were made to the conclusions of the review.
4 February 2002	New search has been performed	Third substantive update first published in Issue 2, 2002 involved: Trial search updated to October 2001. Inclusion of two new studies evaluating the Medoff plate (Lunsjo 2001; Olsson 2001); the exclusion of one other study and the addition of three studies into Studies awaiting assessment. No changes were made to the conclusions of the review.
7 May 2001	Amended	Minor update first published in Issue 3, 2001, comprised three minor changes (in Background and Discussion) made in response to comments received via Philippa Middleton (March 2001).
5 February 2001	New search has been performed	Second substantive update first published in Issue 2, 2001 involved: Trial search update to January 2001. Inclusion of a new study (Lizaur Utrilla 1998) comparing RAB plate with the sliding hip screw. There was no change to the conclusions.
8 May 2000	New search has been performed	First substantive update first published in Issue 3, 2000 involved: Trial search update to October 1999. Inclusion of a new study (Lunsjo 1999) comparing Medoff plate with one of three screw-plate systems in patients with subtrochanteric fractures. Addition of synopsis. Presentation of relative risks instead of Peto odds ratios for dichotomous outcomes. There was no change to the conclusions.

CONTRIBUTIONS OF AUTHORS

Martyn Parker initiated the review, and compiled the first drafts of the protocol and review, subsequent revisions and review updates. For this update, Avishek Das contributed as an author, including assessing risk of bias.

Martyn Parker is the guarantor of the review.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- Peterborough and Stamford Hospitals NHS Foundation Trust, Peterborough, UK.

External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Risk of bias assessment replaced the previous assessment of methodological quality.

INDEX TERMS

Medical Subject Headings (MeSH)

*Bone Nails; *Bone Plates; *Bone Screws; Fracture Fixation [adverse effects] [*instrumentation]; Hip Fractures [*surgery]; Randomized Controlled Trials as Topic

MeSH check words

Aged; Aged, 80 and over; Female; Humans; Male