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Internal fixation implants for intracapsular hip fractures in adults

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ABSTRACT

This is a protocol for a Cochrane Review (Intervention). The objectives are as follows:

To determine the relative effects (benefits and harms) of different implants for the internal fixation of intracapsular hip fractures in adults.

BACKGROUND

Description of the condition

Epidemiology

A hip fracture, or proximal femoral fracture, is a break in the upper region of the femur (thigh bone) between the subcapital region (the area just under the femoral head) and five centimetres below the lesser trochanter (a bony projection of the upper femur). Hip fractures have a rising incidence with age; they are most common in the older adult population (Court-Brown 2017; Kanis 2001). Those in younger adults are usually associated with poor bone health (Karantana 2011; Rogmark 2018). A very small proportion of fractures occurring in younger people are as a result

of high energy trauma such as road traffic collisions and sports injuries. The overwhelming majority of hip fractures are fragility fractures associated with osteoporosis; such fractures result from mechanical forces that would not ordinarily result in fracture. The World Health Organisation has defined fragility fracture as those sustained from injuries equivalent to a fall from a standing height or less (Kanis 2001). In the UK, the mean age of a person with hip fracture is 83 years and approximately two-thirds occur in women (NHFD 2017).

Hip fractures are a major healthcare problem at the individual and population level, presenting a huge challenge and burden to patients, healthcare systems and society. The increased proportion of older adults in the world population means that the absolute number of hip fractures is rising rapidly across the globe. For example, in 2016, there were 65,645 new presentations of hip fracture to 177 trauma units in England, Wales and Northern Ireland (NHFD 2017). Based on mid-2016 population estimates for

these regions, this equates to an incidence rate of 108 cases per 100,000 population (ONS 2018). By 2050, it is estimated that the annual worldwide incidence will be six million hip fractures (Cooper 2011; Johnell 2004). Incident hip fracture rates are higher in industrialised countries as compared with developing countries. The highest hip fracture rates are seen across northern Europe and the US and the lowest in Latin America and Africa (Dhanwal 2011). There is also a north-south gradient seen in European studies and, similarly, more fractures are seen in the north of the US than in the south (Dhanwal 2011). The factors responsible for this variation are thought to be population demographics (with more elderly populations in countries with higher incidence rates) and the influence of ethnicity, latitude, and environmental factors such as socioeconomic deprivation (Bardsley 2013; Cooper 2011; Dhanwal 2011; Kanis 2012).

Burden of disease

Hip fractures are also associated with a high risk of death. For example, in England, Wales and Northern Ireland, the 30-day mortality rate in 2016 remained high at 6.7% despite a decline from 8.5% in 2011 and 7.1% in 2015 (NHFD 2017). Mortality at one year following a hip fracture is approximately 30%; however, fewer than half of the deaths are attributable to the fracture itself, reflecting the frailty of the patients and associated high prevalence of comorbidities and complications (Parker 1991; SIGN 2009). Morbidity associated with hip fractures is similar to stroke in terms of impact with a substantial loss of healthy life-years in older people (Griffin 2015). As such, hip fractures commonly result in reduced mobility and greater dependency, with many people failing to return to their pre-injury residence. In addition, the public health impact of hip fractures is significant: data from large prospective cohorts show the burden of disease due to hip fracture is 27 DALYs (Disability-Adjusted Life Years) per 1000 individuals, which equates to an average loss of 2.7% of the healthy life expectancy in this population at risk of fragility hip fracture (Papadimitriou 2017).

The direct economic burden of hip fractures is also substantial. Hip fractures are among the most expensive conditions seen in hospitals with an aggregated cost of nearly USD 4.9 billion for 316,000 inpatient episodes in the US in 2011 (Torio 2011). In England, Wales and Northern Ireland, hip fracture patients occupy 1.5 million hospital bed days each year, and cost NHS and social care GBP 1 billion (NHFD 2017). Combined health and social care costs incurred during the first year following a hip fracture have been estimated at USD 43,669, which is greater than the cost for non-communicable diseases such as acute coronary syndrome (USD 32,345) and ischaemic stroke (USD 34,772) (Williamson 2017). In established market economies, hip fractures represent 1.4% of the total healthcare burden (Johnell 2004).

Intracapsular hip fracture

Hip fractures either involve the region of the femur which is enveloped by the ligamentous hip joint capsule (intracapsular), or that outside the capsule (extracapsular). Intracapsular fractures include subcapital (immediately below the femoral head), transcervical (across the mid-femoral neck), or basicervical (across the base of the femoral neck). These injuries are also commonly termed fractures of the 'neck of femur' (Lloyd-Jones 2015).

Intracapsular fractures can be further subdivided by fracture morphology using several different classification systems, such as the Garden (Garden 1961) or Pauwels (Pauwels 1935) classifications. The reliability of these various classifications is poor (Parker 1993; Parker 1998). A more appropriate grouping distinguishes only those fractures which are displaced, where the anatomy of the bone has been disrupted at the fracture site, and those which are undisplaced (Blundell 1998; Parker 1999). This system broadly corresponds with prognosis - the more displaced, the more likely the blood supply to the femoral head is compromised, which can lead to complications such as avascular necrosis (localised death of bone tissue due to loss of blood supply to the bone) and subsequent collapse of the femoral head. Furthermore, displaced fractures are less stable, so that treatments involving fixation have a higher risk of failure compared with undisplaced fractures. Approximately 60% of hip fractures are intracapsular; of these, approximately 70% to 90% are displaced (Keating 2010; NHFD 2017).

Description of the intervention

Internationally, many guidelines exist concerning hip fracture management (e.g. AAOS 2014; NICE 2011; SIGN 2009). Each recommend that early surgical management, generally within 24 to 48 hours, is the mainstay of care for the majority of hip fractures. The overall goal of surgery in the older population is to facilitate early rehabilitation, enabling early mobilisation and the return to pre-morbid function while minimising the complication risk. This approach has been associated with reductions in mortality in many worldwide registries (Neufeld 2016; Sayers 2017).

For intracapsular fractures that are treated surgically, two types of operative strategy are commonly employed: joint preserving surgery where the fracture is fixed with various types of internal fixation or prosthetic replacement with any one of a number of arthroplasty options. This review will assess evidence concerning internal fixation. A review on arthroplasties is being developed concurrently. A description of internal fixation implants is given in Table 1.

Once the decision is made to preserve the hip joint, the surgeon must elect whether to reduce (realign the break) or fix the fracture in situ. In general, displaced fractures must be reduced and undisplaced fractures are fixed in situ. Quality of the reduction is an important predictor of a successful outcome after fixation. Typically, fragility fractures are reduced closed, under X-ray control using an image intensifier. However, if a fracture is irreducible using closed

means, the fracture may be reduced open (exposed surgically to aid reduction). The reduced fracture is then held by an implant passed across the fracture under X-ray guidance. This may then be secondarily attached to a plate, which is attached to the outer aspect of the femur. These plates are designed to create an angular-stable implant that may confer biomechanical advantages to the bone-implant construct.

Numerous implants have been developed for internal fixation of intracapsular hip fractures. Implants may be divided into those which are smooth (pins) and those which are threaded (screws). The diameter, thread depth, and pitch and core of these screws each vary. In addition, the proportion of the screw which is threaded may vary from the tip only to running the entire length of the screw. The number of pins or screws inserted across the fracture can vary from one to in excess of 10, depending on the size of the implant used. Screws or pins may also be connected to a side plate that is then fixed with screws to the side of the femur.

Implants that are attached to a side plate are grouped into static and dynamic designs. In static designs, the part of the implant that crosses the fracture is fixed in relation to the side plate; in dynamic designs, this can slide within the side plate allowing collapse of the fracture along the axis of the femoral neck until the fracture is stable.

How the intervention might work

The performance of a bone-implant construct is dependent upon the material and structural properties of the construct as well as the quality of the bone into which it is placed. Fixation fails when the loading forces on the bone-implant construct exceed those that the construct can resist. In osteoporotic fractures, this usually occurs in the bone at the bone-implant interface. This mode of failure is frequently gradual and may lead to mal-union or ultimately a catastrophic failure of fixation.

Therefore, different designs of implants and, consequently, different bone-implant constructs may contribute to the risk of fixation failure. Different implants might influence the risk of the major fracture-related complications reported after internal fixation of non-union, fixation failure, avascular necrosis, and unplanned further surgery.

Why it is important to do this review

This review will replace the Cochrane Review, [Parker 2001](#), on the same topic. We will use up-to-date review methods and optimise current relevance in terms of patient population, implants used and outcomes for policy-making bodies such as the National Institute for Health and Care Excellence (NICE) in the UK, as well as international audiences. Since [Parker 2001](#), clinical uncertainty

remains as to the optimum implant for this patient population; moreover, further studies have been reported since the last search (November 2010).

OBJECTIVES

To determine the relative effects (benefits and harms) of different implants for the internal fixation of intracapsular hip fractures in adults.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs) and quasi-RCTs assessing internal fixation implants for treating patients with intracapsular hip fracture will be eligible for inclusion in the review. Quasi-RCTs are defined as trials in which the methods of allocating people to a trial are not random, but were intended to produce similar groups when used to allocate participants ([Cochrane 2018](#)). Studies published as conference abstracts will be eligible for inclusion in the review provided sufficient data relating to the methods and outcomes of interest are reported. Unpublished data will also be considered for inclusion.

Types of participants

Population

In order to be able to report the generality of evidence available for these patients, we plan to take a wide and pragmatic approach to defining the eligibility criteria. Details of the population will be reported in detail in the Characteristics of Included Studies table. As a benchmark, thus representative of the general hip fracture population, we would expect trial populations to have a mean age of between 80 to 85 years, and include 70% women, 30% with chronic cognitive impairment, and 50% with an American Society of Anesthesiologists (ASA) score greater than 2 ([NHFD 2017](#); [NICE 2011](#)).

Inclusion criteria

- All adults with a fragility (low energy trauma) intracapsular hip fracture (displaced or undisplaced) undergoing surgery.

Exclusion criteria

Studies focusing exclusively on the treatment of the following:

- Patients younger than 16 years;
- Patients with fractures caused by specific pathologies other than osteoporosis;
- Patients with high energy fractures.

Studies with mixed populations (fragility and other mechanisms, ages, or pathologies) will also be eligible for inclusion. Where data are reported separately, we will extract these subgroup data. Where a study has a mixed population, but subgroups are not reported, the proportion of patients who have standard fragility fracture is very likely to hugely outnumber the numbers with high energy or local pathological fractures; therefore, the results will be generalisable to the fragility fracture population. We will consider sensitivity analyses, where possible, to test this assumption (see [Sensitivity analysis](#)).

Healthcare setting

The expected healthcare setting will be hospitals where operative acute care is undertaken.

Types of interventions

Implants used for internal fixation of an intracapsular proximal femoral fracture are as follows:

- Smooth pins: single or multiple;
- Screw treatment: single or multiple;
- Fixed angle plates: static or dynamic.

We plan to create a more detailed table of interventions, grouping them into those that can be reasonably grouped and indicating which are in worldwide use. We will perform this with clinical authors and with the [International Fragility Fracture Network](#). A preliminary exercise resulted in the proposed implant groupings given in [Table 1](#).

Comparisons

We will compare all groups of interventions with each other. We will conduct comparisons at two levels:

1. Major grouping level, e.g. fixed angle plate versus screws;
2. Within group comparison, e.g. multiple screws versus single screw.

When deciding the order of interventions in a comparison, we will generally select the less complex or older, more traditional intervention as the control group

Types of outcome measures

Critical outcomes

We will extract information on the following seven 'critical' outcomes, where reported. These are listed in alphabetical order below. Depending on the length of follow-up reported, the endpoints for each of these outcomes will be categorised into early (up to and including 4 months) and late (after 4 months). We have selected 4 months as the definition of early because most of early recovery has been achieved at this timepoint ([Griffin 2015](#)). This is also in accordance with the core outcome set for hip fracture, which prioritises early outcome over late recovery ([Haywood 2014](#)). Although priority will be given to outcome at 4 months, we will consider data availability in our selection of data for presentation.

- Activities of daily living (e.g. Barthel Index (BI), Functional Independence Measure (FIM));
- Delirium using recognised assessment scores such as Mini Mental test score or 4AT;
- Functional status (region specific) (e.g. hip rating questionnaire, Harris Hip Score, Oxford Hip Score);
- Health-related Quality-of-Life (HRQoL) (e.g. SF36, EQ-5D);
- Mobility (e.g. indoor/outdoor walking status, Cumulated Ambulation Score, Elderly Mobility Scale Score, Timed up and go, Short Physical Performance Battery, self-reported walking scores (e.g. Mobility Assessment Tool - short form));
- Mortality;
- Unplanned return to theatre: secondary procedure required for a complication resulting directly or indirectly from the index operation/primary procedure.

Other important outcomes

We will also report the following 'important' outcomes. Where relevant, we will also categorise these into early (up to and including 4 months) and late (after 4 months).

- Pain (verbal rating or visual analogue scale);
- Length of in-hospital stay (LOS);
- Discharge destination. This may be variably defined in the included studies. We will use the study authors' definitions and report all events without a time limit;
- Adverse events.

We will group adverse events by relatedness to the implant and/or fracture. We will report each adverse event type separately for maximum clarity. We anticipate that events may include:

Related:

- Damage to a nerve, tendon or blood vessel;
- Intraoperative peri-implant fracture;
- Postoperative peri-implant fracture;
- Wound infection (as defined by trial investigators; often infection is described as deep or superficial);
- Non-union. This may be variably defined in the included studies using various means of diagnosis. We will use authors' definitions and report all events diagnosed within the first year following injury;

- Avascular necrosis. This may be variably defined in the included studies using various means of diagnosis. We will use authors' definitions and report all events without a time limit.

Unrelated:

- Acute kidney injury;
- Blood transfusion;
- Cerebrovascular accident;
- Chest infection/pneumonia;
- Decreased cognitive ability;
- Myocardial infarction/acute coronary syndrome;
- Sepsis;
- Urinary tract infection;
- Venous thromboembolic phenomena.

Search methods for identification of studies

We will search for all published, unpublished and ongoing relevant RCTs, without restrictions on language or date. Animal studies will be removed, where possible, using the strategy.

We will develop general search strategies for the large bibliographic databases to find records to feed into a number of Cochrane reviews on hip fracture surgery. We will use three approaches to identifying eligible studies. The approaches are described conceptually as:

1. Hip fractures AND RCT filter;
2. Hip replacement AND fractures AND RCT filter;
3. Internal fixtures AND hip fractures AND RCT filter;
4. 1 OR 2 OR 3.

In MEDLINE, we will use the sensitivity-maximising version of the Cochrane Highly Sensitive Search Strategy for identifying randomised trials (Lefebvre 2018). In Embase, we will use the Cochrane Embase filter (<https://www.cochranelibrary.com/central/central-creation>) to focus on RCTs.

Electronic searches

We will search the following electronic databases from their inception:

- Cochrane Central Register of Controlled Trials (CENTRAL);
- MEDLINE ALL (Ovid);
- Embase (Ovid);
- Science Citation Index (Web of Science);
- Cochrane Database of Systematic Reviews (CDSR) (Cochrane Library);
- Database of Abstracts of Reviews of Effects (DARE) (Centre for Reviews and Dissemination website);
- Health Technology Assessment (HTA) database (Centre for Reviews and Dissemination website);
- Epistemonikos (<https://www.epistemonikos.org/>);
- ClinicalTrials.gov (<https://clinicaltrials.gov/>);
- WHO International Clinical Trials Registry Platform (ICTRP) (www.who.int/ictpr/en/).

As CENTRAL is kept fully up-to-date with all records from the BJMT Group's Specialised Register, we do not plan to search the latter separately.

The search strategies for the above databases will be modelled on the search strategy designed for MEDLINE (Appendix 1), where possible. Adaptation includes consideration of database interface differences as well as adaptation to different indexing languages. The final search strategies for each of the databases searched will be documented in the review.

Searching other resources

Unpublished research, conference reports, or research reported in the grey literature will be sought by searching a range of resources including:

- Hand searching of abstracts from the following conferences (2016 to present):
 - Fragility Fractures Network Congress;
 - British Orthopaedic Association Congress;
 - Orthopaedic World Congress (SICOT);
 - Orthopaedic Trauma Association Annual Meeting;
 - Bone and Joint Journal Orthopaedic Proceedings;
 - American Academy of Orthopaedic Surgeons Annual Meeting;
- Proquest Dissertations and Theses;
- National Technical Information Service (NTIS, for technical reports).

To identify further studies, we will screen the reference lists of eligible studies and systematic reviews published within the last five years that have been retrieved by the searches. We will screen the reference lists of the Cochrane reviews that are being updated here, irrespective of the date they were published.

Data collection and analysis

Any review author who is a co-applicant, author or has or has had an advisory role on any potentially relevant study, will remain independent of study selection decisions, risk of bias assessment and data extraction for their study.

Selection of studies

Two review authors will screen titles and abstracts of all the retrieved bibliographic records in a web-based systematic reviewing platform, Rayyan (Ouzzani 2016). Full texts of all potentially eligible records passing the title and abstract screening level will be retrieved and examined independently by two review authors with the eligibility criteria mentioned in [Criteria for considering studies for this review](#). Full-text screening will be carried out in another web-based platform, Covidence (Covidence). Disagreements will be resolved by discussion or adjudication by another author. Where

necessary, we will correspond with trial investigators where clarification is required to inform study selection. Duplicates will be excluded and multiple reports of the same study collated so that each study, rather than each report, is the unit of interest in the review. A PRISMA flow-diagram (Moher 2009) will outline the study selection process, numbers of records at each stage of selection, and reasons for exclusions of full-text articles. Details will also be recorded in a 'Characteristics of Excluded Studies' table.

Data extraction and management

Data will be extracted independently by two reviewers using a pre-piloted structured form to ensure consistency of information and appraisal of each study. The form will be piloted independently on at least one study before implementation. The two review authors will ascertain that the data are entered correctly into the final data set. Data to be extracted include the following:

Study methodology

Publication type; sponsorship and funding for the trial and any notable conflicts of interest of trial authors; study design; trial phase; number of centres and locations; size and type of setting (e.g. in-hospital or out-of-hospital or mixed or community); study period and length of follow-up; stated study objectives; study inclusion and exclusion criteria; randomisation method; masking; study disposition (number randomised, number by protocol, number available for analysis).

Population

Baseline characteristics of the participants; these include age, gender, comorbidities, functional status such as previous mobility, fracture type and displacement, and cognitive status.

Interventions

We plan to extract data concerning the exact nature of the interventions tested and any reported co-interventions. These data may include more detailed intervention descriptions, for example: screw and pin treatments (number and type) and plate treatment (type and dynamic versus static). We will also extract, where available, information on any co-interventions, for example, preoperative care (e.g. prophylaxis - antibiotics, venous thromboembolism, delirium); anaesthetic management; and postoperative care (e.g. rehabilitation).

Outcome data

Where possible, we will extract data by arm rather than the summary effect sizes. Outcome worksheets will be in 'one study per row format' and specify the number of arms for each study and number of participants in each arm; numbers randomised and

analysed for each outcome at each time point; number of events in each arm (for rate, binary or categorical data); and means and standard deviations, effect measures, point estimates and confidence limits (for continuous variables). Where available, outcomes will be split into early and late, as described.

Assessment of risk of bias in included studies

Risk of bias will be assessed in the included studies using the tool described for standard systematic reviews in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011a). The assessment will be performed by two independent review authors and any discrepancies will be resolved through discussion or by consulting a third author. Where details of methods are unclear or not reported, study authors will be contacted for more information.

Risk of bias will be evaluated in the following domains: selection bias (random sequence generation and allocation concealment), performance bias (blinding of participants and personnel), detection bias (blinding of outcome assessment), attrition bias (incomplete outcome data), reporting bias (selective reporting) and other bias. Each potential source of bias will be graded as high, low or unclear and a quote will be provided from the study report together with a justification for our judgement in the 'Risk of bias' table. The 'Risk of bias' judgements will be summarised across different studies for each of the domains listed.

Assessment of risk of bias is specific to a particular result for a particular outcome (and time point) in the study. However, some domains will apply generally to the whole study (such as random sequence generation and allocation concealment); some will apply mainly to the outcome being measured or measurement method being used (such as blinding of participants and personnel, and blinding of outcome assessment); and some will apply to the specific result (such as selective reporting bias).

In the domains specific to particular outcomes, considerations of risk of bias for different *types* of outcomes will be given and assessments made separately, for example for participant-reported outcomes (e.g. pain, HRQoL), observer-reported outcomes not involving judgement (e.g. all-cause mortality), observer-reported outcomes involving some judgement (e.g. assessment of a radiograph, clinical examination and clinical events other than death), outcomes that reflect decisions made by the intervention provider (e.g. hospitalisation, stopping treatment, referral to a different ward and discharge of the patient), and composite outcomes (e.g. major cardiac and cerebrovascular events (MACCE)).

As trials frequently contribute multiple results, mainly through contributing to multiple outcomes, several 'Risk of bias' assessments may be needed for each study. These assessments are likely to align with the outcomes included in a 'Summary of Findings' (SoF) table.

Measures of treatment effect

We will calculate risk ratios (RRs) for dichotomous data outcomes with 95% confidence intervals (CI). Where the number of observed events is very low (less than 1% of the sample per group or with zero events in either arm) and where trials have balanced treatment groups, we will report the Peto odds ratio (OR) with 95% CI (Deeks 2017). We will express treatment effects for continuous data outcomes as mean differences (MD) with 95% CI; if the outcomes are measured using different scales, we will use standardised mean differences (SMD) with 95% CI.

Unit of analysis issues

We anticipate that the patient will be the unit of analysis. We do not expect to encounter any within-person randomised trials or cluster-randomised trials. If we do identify any, we will treat them in accordance with the advice given in Chapter 16 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b). We expect outcomes to be reported at various time points. We have specified long- and short-term follow-up analyses in [Types of outcome measures](#). We will also treat results from multi-arm trials in accordance with the advice given in Chapter 16 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b).

Dealing with missing data

Where sufficiently reported, we will analyse data on an intention-to-treat basis. We will contact the trial authors to attempt to obtain missing data or to clarify unclear data. For each included study, we will record the number of participants lost to follow-up. Our primary analysis will be a complete case analysis; we do not plan to impute missing data. However, if large amounts of data are missing then we will consider exploratory sensitivity analyses to investigate possible effects of the missingness (see [Sensitivity analysis](#)). Where standard deviations are not reported, we will try to determine these from standard errors, confidence intervals, or exact P values.

Assessment of heterogeneity

We will use the I^2 statistic, automatically calculated in the Revman software, to quantify the possible degree of heterogeneity of treatment effects between trials. We will assume moderate heterogeneity when the I^2 is between 30% and 60%; substantial heterogeneity when it is between 50% and 90%; and considerable heterogeneity when it is between 75% and 100%. We will keep in mind that the importance of I^2 depends on: 1) magnitude and direction of effects; and 2) strength of evidence for heterogeneity. If we identify substantial heterogeneity, we will report it and investigate possible causes by using subgroup analyses where feasible (Deeks 2017). We will assess clinical and methodological diversity in terms of participants, interventions, outcomes, effect modifiers, and study characteristics for the included studies to determine whether a meta-analysis is appropriate. We will conduct this by observing these data from the data extraction tables.

We will then visually inspect the forest plot to look at the consistency of intervention effects across included studies. If the studies are estimating the same intervention effect, there should be overlap between the confidence intervals for each effect estimate on the forest plot, but if overlap is poor, or there are outliers, then statistical heterogeneity may be likely.

Assessment of reporting biases

Where sufficient numbers of studies (more than 10) are available for meta-analysis, we will construct a funnel plot to identify the potential for publication bias as well as to explore possible small study biases. In interpreting funnel plots, we will examine the different reasons possible for funnel plot asymmetry and relate this to the results of the review. We will also undertake formal statistical tests to investigate funnel plot asymmetry, and will follow the recommendations in section 10.4 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Sterne 2017).

To assess outcome reporting bias, we will check trial protocols against their published reports. We will also screen clinical trial registries for a priori trial protocols. We will evaluate whether selective reporting of outcomes is present.

Data synthesis

We will undertake meta-analyses only where this is meaningful, that is, if the treatments, participants, and the underlying clinical question are similar enough for pooling to make sense. When considered appropriate, we will pool results of comparable groups of trials using random-effects models. This choice of the model was chosen after careful consideration of the extent to which any underlying effect could truly be thought to be fixed given the complexity of the interventions included in this review. We will present 95% CIs throughout.

We will consider not pooling data where there is considerable heterogeneity (I^2 statistic value of greater than 75%) that cannot be explained by the diversity of methodological or clinical features among trials. We will still present trial data in the analyses or tables for illustrative purposes and report these in the text.

When considered appropriate, we will pool data using the generic inverse variance method in RevMan (Review Manager 2014). This method enables pooling of the adjusted and unadjusted treatment effect estimates (RaRs or RRs) reported in the individual studies or which can be calculated from data presented in the published article (see [Measures of treatment effect](#)). The generic inverse variance option in RevMan requires entering the natural logarithm of the RaR or RR and its standard error for each trial; we will calculate these using the RevMan calculator (Review Manager 2014).

Subgroup analysis and investigation of heterogeneity

If sufficient studies are available, we will explore as possible sources of heterogeneity between studies key effect modifiers such as age

(cut-off 85 years), gender, cognitive impairment, baseline functional status, and fracture displacement.

We will investigate whether the results of subgroups are significantly different by inspecting overlapping CIs and by performing the test for subgroup differences available in Review Manager (Review Manager 2014), where appropriate.

There is no explicit means of accounting for step changes in co-interventions, certainly not one that would be applicable to the worldwide totality of the evidence. Therefore, we cannot try to explain any heterogeneity by statistical test of subgroups defined by co-intervention. However, we will order forest plots by date of recruitment so that any temporal trend can be inspected visually and commented on.

Sensitivity analysis

If a sufficient number of studies meet the inclusion criteria, we will assess the effect of excluding the following types of studies.

- At high risk of bias
- Have substantial amounts of missing data
- Have quasi methods of randomisation
- Have mixed population
- Report interventions that are not currently in clinical use

GRADE assessment and 'Summary of findings' tables

Two authors will independently assess the certainty of evidence for each of the seven primary ('critical') outcomes using the GRADE approach developed by the international GRADE working group (<http://www.gradeworkinggroup.org/>). The software developed by the GRADE working group (GRADEpro GDT 2015) will be used to assess the quality of evidence for each outcome, taking into account individual study factors and the meta-analysis results. We will also present the results and the certainty of evidence for the

main outcomes in a SoF table using GRADEPro (Schünemann 2019).

The chosen outcomes are those we consider to be most clinically important and useful for readers; these are described under 'Critical outcomes' in [Types of outcome measures](#). We will consider the GRADE domains: risk of bias, inconsistency, indirectness, imprecision, and publication bias (Guyatt 2008). Disagreements will be resolved by a third reviewer. The certainty of the evidence could be high, moderate, low or very low, being downgraded by one or two levels depending on the presence and extent of concerns in the five GRADE domains. Footnotes will be used to describe reasons for grading a domain as having 'serious' or 'very serious' problems and we will make further comments to aid the reader's understanding of the SoF table, where necessary. We will consider the certainty of the evidence and the effect when making conclusions. We will also provide a rationale for the figure used to calculate the assumed risk in a footnote.

Further details on the full method used for GRADE assessment of outcomes will be given in an appendix in the fully published review.

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REFERENCES

Additional references

AAOS 2014

American Academy of Orthopaedic Surgeons (AAOS). Management of hip fractures in the elderly. Evidence-based clinical practice guideline. www.aaos.org/research/guidelines/HipFxGuideline.pdf (accessed 22 March 2019).

Bardsley 2013

Smith P, Ariti C, Bardsley M, Nuffield Trust & Health Foundation. Focus on hip fracture. Trends in emergency admissions for fractured neck of femur, 2001 to 2011. www.nuffieldtrust.org.uk/research/focus-on-hip-fracture (accessed 9 January 2019).

Blundell 1998

Blundell CM, Parker MJ, Pryor GA, Hopkinson-Woolley

J, Bonsall SS. An assessment of the AO classification of intracapsular fractures of the proximal femur. *Journal of Bone and Joint Surgery. British Volume* 1998;**80**(4):679–83.

Cochrane 2018

Cochrane. Glossary. community.cochrane.org/glossary (accessed 2 November 2018).

Cooper 2011

Cooper C, Cole ZA, Holroyd CR, Earl SC, Harvey NC, Dennison EM, et al. Secular trends in the incidence of hip and other osteoporotic fractures. *Osteoporosis International* 2011;**22**(5):1277–88.

Court-Brown 2017

Court-Brown CM, Clement ND, Duckworth AD, Biant LC, McQueen MM. The changing epidemiology of fall-related fractures in adults. *Injury* 2017;**48**(4):819–24.

Covidence [Computer program]

Veritas Health Innovation. Covidence. Version accessed 29 July 2019. Melbourne, Australia: Veritas Health Innovation, 2003.

Deeks 2017

Deeks JJ, Higgins JPT, Altman DG, Cochrane Statistical Methods Group. Chapter 10: Analysing data and undertaking meta-analyses. In: Higgins JPT, Thomas J, Chandler J, Cumpston MS, Li T, Page MJ, Welch V (editors). *Cochrane Handbook for Systematic Reviews of Interventions* Version 6.0 (updated September 2018). The Cochrane Collaboration, 2018. Available from training.cochrane.org/handbook.

Dhanwal 2011

Dhanwal DK, Dennison EM, Harvey NC, Cooper C. Epidemiology of hip fracture: worldwide geographic variation. *Indian Journal of Orthopaedics* 2011;**45**(1):15–22.

Garden 1961

Garden RS. Low-angle fixation in fractures of the femoral neck. *Bone & Joint Journal* 1961;**43-B**(4):647–63.

GRADEpro GDT 2015 [Computer program]

McMaster University (developed by Evidence Prime, Inc.). GRADEpro GDT. Version (accessed 9 January 2019). Hamilton (ON): McMaster University (developed by Evidence Prime, Inc.), 2015.

Griffin 2015

Griffin XL, Parsons N, Achten J, Fernandez M, Costa ML. Recovery of health-related quality of life in a United Kingdom hip fracture population: the Warwick Hip Trauma Evaluation – a prospective cohort study. *Bone & Joint Journal* 2015;**97-B**(3):372–82.

Guyatt 2008

Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ* 2008;**336**(7650):924–6.

Haywood 2014

Haywood KL, Griffin XL, Achten J, Costa ML. Developing a core outcome set for hip fracture trials. *Bone and Joint Journal* 2014;**96-B**(8):1016–23.

Higgins 2011a

Higgins JPT, Altman DG, editor(s). Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Green S, editor(s). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Higgins 2011b

Higgins JPT, Deeks JJ, Altman DG, editor(s). Chapter 16: Special topics in statistics. In: Higgins JPT, Green S, editor(s). *Cochrane Handbook for Systematic Reviews of Interventions*. Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Johnell 2004

Johnell O, Kanis JA. An estimate of the worldwide prevalence, mortality and disability associated with hip fracture. *Osteoporosis International* 2004;**15**(11):897–902.

Kanis 2001

Kanis JA, Oden A, Johnell O, Jonsson B, De Laet C, Dawson A. The burden of osteoporotic fractures: a method for setting intervention thresholds. *Osteoporosis International* 2001;**12**(5):417–27.

Kanis 2012

Kanis JA, Oden A, McCloskey EV, Johansson H, Wahl DA, Cooper C. A systematic review of hip fracture incidence and probability of fracture worldwide. *Osteoporosis International* 2012;**23**(9):2239–56.

Karantana 2011

Karantana A, Boulton C, Bouliotis G, Shu KS, Scammell BE, Moran CG. Epidemiology and outcome of fracture of the hip in women aged 65 years and under: a cohort study. *Journal of Bone Joint Surgery - British volume* 2011;**93**(5):658–64.

Keating 2010

Keating J. Femoral neck fractures. In: Bucholz RW, Heckman JD, Court-Brown CM, Tornetta P III editor (s). *Rockwood and Green's Fractures in Adults*. 7. Vol. 2, Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins, 2010.

Lefebvre 2018

Lefebvre C, Glanville J, Briscoe S, Littlewood A, Marshall C, Metzendorf M-I, et al. Chapter 4: Searching for and selecting studies. Draft version (13 September 2018) for inclusion in Higgins JPT, Thomas J, Chandler J, Cumpston MS, Li T, Page MJ, Welch V (editors). *Cochrane Handbook for Systematic Reviews of Interventions*. London: Cochrane.

Lloyd-Jones 2015

Lloyd-Jones G. Trauma x-ray - lower limb. Hip fracture. www.radiologymasterclass.co.uk/tutorials/musculoskeletal/x-ray_trauma_lower_limb/hip_fracture_x-ray (accessed 10 August 2018).

Moher 2009

Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLOS Medicine* 2009;**6**(7):e1000097.

Neufeld 2016

Neufeld ME, O'Hara NN, Zhan M, Zhai Y, Broekhuijsen HM, Lefavre KA, et al. Timing of hip fracture surgery and 30-day outcomes. *Orthopedics* 2016;**39**(6):361–8.

NHFD 2017

NHFD. The National Hip Fracture Database (NHFD) annual report 2017. www.nhfd.co.uk/ (accessed 30 October 2018).

NICE 2011

National Clinical Guideline Centre (UK). The management of hip fracture in adults. NICE clinical guidelines, no. 124.

- www.nice.org.uk/guidance/cg124/evidence/full-guideline-pdf-183081997 (accessed 30 October 2018).
- ONS 2018**
Office for National Statistics. Mid-2018 population estimates for the UK, England and Wales, Scotland and Northern Ireland. <https://bit.ly/2XBLgy6> (accessed 1 August 2019).
- Ouzzani 2016**
Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. *Systematic Reviews* 2016;**5**(1):210.
- Papadimitriou 2017**
Papadimitriou N, Tsilidis KK, Orfanos P, Benetou V, Ntzani EE, Soerjomataram I, et al. Burden of hip fracture using disability-adjusted life-years: a pooled analysis of prospective cohorts in the CHANCES consortium. *Lancet Public Health* 2017;**2**(5):e239–e46.
- Parker 1991**
Parker MJ, Anand JK. What is the true mortality of hip fractures?. *Public Health* 1991;**105**(6):443–6.
- Parker 1993**
Parker MJ. Garden grading of intracapsular fractures: meaningful or misleading?. *Injury* 1993;**24**(4):241–2.
- Parker 1998**
Parker MJ, Dynan Y. Is Pauwels classification still valid?. *Injury* 1998;**29**(7):521–3.
- Parker 1999**
Parker MJ. Proximal femoral fractures. In: Pynsent PB, Fairbank JCT, Carr AJ editor(s). *Classification of Musculo-Skeletal Trauma*. Oxford (UK): Butterworth-Heinemann Publications, 1999.
- Parker 2001**
Parker MJ, Gurusamy KS. Internal fixation implants for intracapsular proximal femoral fractures in adults. *Cochrane Database of Systematic Reviews* 2001, Issue 4. DOI: 10.1002/14651858.CD001467
- Pauwels 1935**
Pauwels F. Der Schenkelhalsbruch. Ein mechanisches Problem. *Gesammelte Abhandlungen zur funktionellen Anatomie des Bewegungsapparates*. Berlin: Heidelberg: Springer, 1935.
- Review Manager 2014 [Computer program]**
Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager 5 (RevMan 5). Version 5.3. Copenhagen: Nordic Cochrane Centre, The Cochrane Collaboration, 2014.
- Rogmark 2018**
Rogmark C, Kristensen MT, Viberg B, Ronnquist SS, Overgaard S, Palm H. Hip fractures in the non-elderly - who, why and whither?. *Injury* 2018;**49**(8):1445–50.
- Sayers 2017**
Sayers A, Whitehouse MR, Berstock JR, Harding KA, Kelly MB, Chesser TJ. The association between the day of the week of milestones in the care pathway of patients with hip fracture and 30-day mortality: findings from a prospective national registry - The National Hip Fracture Database of England and Wales. *BMC Medicine* 2017;**15**:62.
- Schünemann 2019**
Schünemann HJ, Higgins JPT, Vist GE, Glasziou P, Akl EA, Skoetz N, et al. Chapter 14: Completing ‘Summary of findings’ tables and grading the certainty of the evidence. Draft version (29 January 2019) for inclusion in: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). *Cochrane Handbook for Systematic Reviews of Interventions*. London: Cochrane.
- SIGN 2009**
Scottish Intercollegiate Guidelines Network (SIGN). Management of hip fracture in older people. A national clinical guideline. www.sign.ac.uk/assets/sign111.pdf (accessed 30 October 2018).
- Sterne 2017**
Sterne JAC, Egger, M, Moher D, Boutron I, editor (s). Chapter 10: Addressing reporting biases. In: Higgins JPT, Churchill R, Chandler J, Cumpston MS, editor(s). *Cochrane Handbook for Systematic Reviews of Interventions Version 5.2.0* (updated June 2017). The Cochrane Collaboration, 2017. Available from training.cochrane.org/handbook.
- Torio 2011**
Torio CM, Andrews RM. National inpatient hospital costs: the most expensive conditions by Payer, 2011. Healthcare Cost and Utilization Project Statistical Brief # 160. www.hcup-us.ahrq.gov/reports/statbriefs/sb160.pdf (accessed 9 January 2019).
- Williamson 2017**
Williamson S, Landeiro F, McConnell T, Fulford-Smith L, Javaid MK, Judge A, et al. Costs of fragility hip fractures globally: a systematic review and meta-regression analysis. *Osteoporosis international* 2017;**28**(10):2791–800.

* Indicates the major publication for the study

ADDITIONAL TABLES

Table 1. Possible grouping of internal fixation implants for intracapsular hip fractures in adults

Implant category	Implant subcategory	Examples ^a	Description
Smooth pins	Single, or multiple pins	<ul style="list-style-type: none"> • Hansson pins • Hessel pins 	<p>A smooth pin is any pin, hook pin, or nail treatment, regardless of the number implanted. Smooth pins are unthreaded and may offer greater stiffness than their threaded counterparts</p> <p>Hansson pin (Elos Medtech, 1982) - a hook pin designed like a Rydell nail (see below), with the same spring pin but with removed flanges</p> <p>Hessel pin - a thin, smooth pin without threads, which is inserted by hammering</p>
	Single or multiple nails	<ul style="list-style-type: none"> • Smith-Petersen nail • Rydell four-flanged nail • Nystrom nails 	<p>Smith-Petersen nail - a three-flanged steel nail introduced in 1925 for insertion across the fracture site in hip fractures</p> <p>Rydell four-flanged nail - a spring-loaded nail which had four flanges and was hammered in over a guide pin. The pin had a curved end which extruded through a hole in the nail and anchored the pin in the bone in order to prevent slippage</p> <p>Nystrom nail - a sharp tipped smooth nail which was hammered across the fracture and thought to have better penetrating ability</p>
Screw treatment	Single, or multiple screws	<ul style="list-style-type: none"> • Garden screws • Richards screws • Tronzon (VLF) screws • Uppsala/Olmed screws • Von Bahr screws • AO screws • Gouffon screws • Mecron screws • Ulleval screws • Scand screws 	<p>Screw treatment refers to any screw providing fixation; the number of screws, size of screws, thread length, diameter and configuration may all vary. Hip screws are typically cancellous screws that have coarser threads and may have an unthreaded portion allowing it to act as a lag screw. However, both fully and partially threaded variants are available</p>
Fixed angle plates	Static	<ul style="list-style-type: none"> • Holt nail plate • Jewett nail plate • McLaughlin nail plate • Thornton nail plate 	<p>Fixed angle plates are static devices consisting of a nail, pin, or screw which is passed across the fracture into the femoral head and connected to a plate on the lateral femur. These implants have no capacity for 'sliding' between the plate and pin or screw components and</p>

Table 1. Possible grouping of internal fixation implants for intracapsular hip fractures in adults (Continued)

			<p>hence are termed static implants</p> <p>Holt nail plate - a four-flanged nail connected to a plate at the time of surgery</p> <p>Jewett nail - the nail is fixed to the plate at manufacture.</p> <p>Thornton and McLaughlin nail plates - the nail is connected to the plate at the time of surgery with a locking bolt</p>
	Dynamic	<ul style="list-style-type: none"> • Dynamic hip screw • Precimed Hip Screw System • Ambi/Classic Hip Screw System (Smith & Nephew Richards) • DHS/DCS Dynamic Hip & Condylar Screw System • Syntec-Taichung DHS/DCS Plate System • Targon Femoral Neck hip Screw 	<p>Dynamic device consisting of a nail, pin, or screw which is passed across the fracture into the femoral head and connected to a plate on the lateral femur. These implants allow 'sliding' between the plate and pin or screw components and hence are termed dynamic implants. Weight-bearing or translation during surgery causes the femoral head to become impacted on the femoral neck producing compression of the fracture</p> <p>Precimed Hip Screw System - compression fixation system used for the treatment of femoral neck and distal femoral fractures. It consists of compression plates, lag screws, compression screws, bone screws and angled blade plates. The system functions to provide immediate stability and temporary fixation during the natural healing process following fractures of the femoral neck or distal femur</p> <p>AMBI/Classic Hip Screw System - compression fixation system consisting of hip screw plates and nails. AMBI plates have a barrel design which is keyless but can be converted to keyed with the insertion of a small keying clip; classic plates have a keyed barrel design only. AMBI/Classic Lag Screws - 18 lengths: 55 mm to 140 mm; nonself-tapping for cancellous bone</p> <p>Targon Femoral Neck screws (B. Braun Group) - distal and proximal screws are linked with a locking plate</p>

^a This list is not exhaustive. In the review, we will add any implant tested in included trials not already listed here.

AO: Arbeitsgemeinschaft für Osteosynthesefragen (German for "Association for the Study of Internal Fixation")

DCS:dynamic condylar screw

DHS: dynamic hip screw

VLF: volar lunate facet

APPENDICES

Appendix I. MEDLINE search strategy

Ovid interface

```
1 exp Femoral Fractures/
2 ((hip or hips or cervical) adj5 (fracture$ or break$ or broke$)).ti,ab,kf.
3 ((femoral$ or femur$ or acetabul$) adj5 (fracture$ or break$ or broke$)).ti,ab,kf.
4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) adj5 (fracture$ or break$ or broke$)).ti,ab,kf.
5 ((extracapsular or extra-capsular or trochant$ or subtrochant$ or pertrochant$ or intertrochant$) adj5 (fracture$ or break$ or broke$)).ti,ab,kf.
6 (((head or neck or proximal) adj5 (fracture$ or break$ or broke$)) and (femoral$ or femur$)).ti,ab,kf.
7 or/1-6
8 randomized controlled trial.pt.
9 controlled clinical trial.pt.
10 randomized.ab.
11 placebo.ab.
12 clinical trials as topic.sh.
13 randomly.ab.
14 trial.ti.
15 8 or 9 or 10 or 11 or 12 or 13 or 14
16 7 and 15
17 Arthroplasty, Replacement, Hip/ or Hip Prosthesis/
18 Arthroplasty, Replacement/ or Hemiarthroplasty/ or Joint Prosthesis/
19 (arthroplast$ or hemiarthroplast$).ti,ab,kf.
20 ((hip or hips) adj5 (replac$ or prothes$ or implant$)).ti,ab,kf.
21 ((joint$1 adj5 (replac$ or prothes$ or implant$)) and (hip or hips or femur$ or femoral$ or acetabul$)).ti,ab,kf.
22 or/17-21
23 fractures, bone/ or exp fracture dislocation/ or fractures, closed/ or fractures, comminuted/ or fractures, compression/ or fractures, malunited/ or fractures, multiple/ or fractures, open/ or fractures, spontaneous/ or exp fractures, stress/ or fractures, ununited/ or intra-articular fractures/ or osteoporotic fractures/ or periprosthetic fractures/ (92406)
24 fracture$.ti,ab,kf.
25 23 or 24
26 22 and 25 and 15
27 (pin or pins or nail or nails or screw or screws or plate or plates).ti,ab,kf.
28 internal fixators/ or bone nails/ or bone plates/ or exp bone screws/
29 (static adj (device$1 or implant$1)).ti,ab,kf.
30 (dynamic adj (device$1 or implant$1)).ti,ab,kf.
31 or/27-30
32 ((hip or hips or femur$ or femoral$ or acetabul$) and (fracture$ or break$ or broke$)).ti,ab,kf.
33 (hip or hips or femur$ or femoral$ or acetabul$).ti,ab,kf. and (fractures, bone/ or exp fracture dislocation/ or fractures, closed/ or fractures, comminuted/ or fractures, compression/ or fractures, malunited/ or fractures, multiple/ or fractures, open/ or fractures, spontaneous/ or exp fractures, stress/ or fractures, ununited/ or intra-articular fractures/ or osteoporotic fractures/ or periprosthetic fractures/)
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34 or/32-33
35 31 and 34 and 15
36 16 or 26 or 35
37 exp animals/ not humans/
38 36 not 37

CONTRIBUTIONS OF AUTHORS

AS (systematic reviewer): drafted the protocol, reviewed and approved the final protocol.

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HW (senior information specialist): design of the search strategies, reviewed and approved the final protocol.

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Contributions of the editorial base

Helen Handoll (Co-ordinating Editor): edited the protocol; advised on methodology and protocol content; and approved the final version for publication.

Joanne Elliott (Managing Editor): coordinated the editorial process; advised on content; and edited the protocol.

Maria Clarke (Information Specialist): checked the search methods section.

DECLARATIONS OF INTEREST

AS: has no known conflicts of interest.

WE: has an advisory role on infection control with Orthofix and Bone Support, but this is unrelated to this review. He has no known conflicts of interest.

HW: has no known conflicts of interest.

JMG: has no known conflicts of interest.

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