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Internal fixation implants for intracapsular hip fractures in adults (Review)

Parker MJ, Gurusamy KS

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Internal fixation implants for intracapsular hip fractures in adults.

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Internal fixation implants for intracapsular hip fractures in adults (Review)

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[Intervention Review]

Internal fixation implants for intracapsular hip fractures in adults

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ABSTRACT

Background

Numerous different implants with screws, pins and side plates have been used for the internal fixation of intracapsular hip fractures.

Objectives

To determine from randomised trials which implant is superior for the internal fixation of intracapsular proximal femoral fractures.

Search methods

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (13 September 2010), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2010, Issue 3), MEDLINE (1950 to August week 5, 2010), EMBASE (1980 to 2010 Week 36), and other sources.

Selection criteria

Randomised and quasi-randomised trials comparing different implants for the internal fixation of intracapsular hip fractures in adults.

Data collection and analysis

Two review authors independently assessed trial quality, by use of an 11 item scale, risk of bias relating to sequence generation and allocation concealment, and extracted data. Additional information was sought from trialists. After grouping by implant type, comparable groups of trials were subgrouped and where appropriate, data were pooled using the fixed-effect model or, where there was significant heterogeneity, the random-effects model.

Main results

There are now 30 studies involving 6334 participants (6339 fractures) included in this review, which was published in 2011. There was considerable variation in the quality of trial methodology and generally inadequate reporting of methods and trial findings. Allocation concealment was confirmed in one trial only. The main outcome measures reported were fracture healing complications, re-operations and mortality. The reporting of functional outcomes was particularly poor.

Few trials tested the same comparison. Most of the results for the 25 separate comparisons, frequently tested within one trial only, showed no statistically significant differences between the two implants under test. It was noted that the more rare findings of favourable results were often for implants developed within the same institutions as the trial. There was a consistent finding of less avascular necrosis with the sliding hip screw in comparison with five different types of cancellous screws but there was no significant difference found for re-operations. Additionally, the sliding hip screw was found to take longer to insert and to have an increased operative blood loss compared with multiple screws or pins.

Internal fixation implants for intracapsular hip fractures in adults (Review)

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Authors' conclusions

No clear conclusions can be made on the choice of implant for internal fixation of intracapsular fractures from the available evidence within randomised trials.

PLAIN LANGUAGE SUMMARY**Different implants used to fix certain types of hip fractures**

Many different types of implants are used to fix fractures of the hip, which are close to the hip joint (intracapsular fractures). Implants are used to stabilise the bone during healing thereby reducing the chance of the bones slipping out of line. They consist of either screws or pins and may have an additional side plate attached, which is fixed to the bone.

This review of randomised controlled trials included 30 studies involving more than 6000 participants. Most of the trials were poorly reported and had flaws in their methods that could have affected their results. Few trials tested the same comparison. Most of the results for the 25 separate comparisons, frequently tested within one trial only, failed to show that one implant was better than the other under comparison. There was a consistent finding of one serious complication (avascular necrosis) with the sliding hip screw in comparison with five different types of cancellous screws. However, this was not reflected in a decrease in re-operations for this group. Additionally, the sliding hip screw was found to take longer to insert and to have an increased operative blood loss compared with multiple screws or pins.

This review found no evidence from trials undertaken so far that there were any major differences between different implants in patient survival or complications related to the operation.

BACKGROUND

Proximal femoral fractures or, as they are more 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). Intracapsular fractures can be further subdivided into those which are displaced and those which are essentially undisplaced. Undisplaced fractures include those termed impacted or adduction fractures. Many other subdivisions and classification methods exist for intracapsular fractures but these have not been shown to be of reliable clinical usefulness (Parker 1993).

Intracapsular hip fractures are generally managed surgically, either by fixing the fracture using various implants and thereby retaining the femoral head, or by replacing the femoral head with a prosthesis. The latter option is not considered in this review. The rationale for operative treatment of intracapsular fractures is to reduce the risk of the fracture displacing, for undisplaced fractures, and to maintain fracture reduction for displaced fractures. Surgery entails passing single or multiple screws or pins across the fracture site. For displaced fractures the fracture must first be reduced, which may be achieved either by an open or closed reduction.

Numerous implants have been developed over time for the internal fixation of the fracture. Tronzo identified over 100 in 1974 (Tronzo 1974). These implants are inserted under X-ray guidance using either an open or percutaneous procedure. Implants may be divided into those which are smooth (pins) and those which are threaded (screws). The type of threads used on screws may vary from narrow to wide and deep. In addition, the proportion of the screw which is threaded may vary from the tip only to the entire length. 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 which is then fixed with screws to the side of the femur. Another variation on implant design is a small metal 'tongue' which is pushed out of the tip of a nail into the subchondral bone of the femur.

Examples of single nails are the Smith-Petersen nail, Thornton nail and Rydell four-flanged nail. Examples of a single nail with a side plate are the Holt, Jewett nail plate, Massie nail, McLaughlin nail plate, Pugh nail and Thornton nail plate. Of these implants, the Massie and Pugh nails have the capacity for sliding at the nail/plate junction, allowing for collapse at the fracture site. Examples of a single screw with a side plate are the sliding hip screw (SHS) and equivalent models such as the Ambi, Dynamic, or Richards' screws. These implants all have the capacity for sliding at the screw/plate junction.

Examples of implants with a 'tongue', which can be extruded from its tip, are the Rydell four-flanged nail and Hansson pins. Examples of implants that are normally used in pairs are Garden screws, Hansson pins, Richards' screws, Tronzo (VLF) screws, Uppsala/Olmed screws, von Bahr screws, and Ullevaal screws. Examples of implants for which three are normally inserted are AO screws, Gouffon screws, Hessel pins, Mecron screws, Nystrom nails, Ullevaal screws and Scand screws.

The main fracture healing complication after internal fixation of an intracapsular fracture is the failure of the fracture to heal. This may lead to fracture displacement and is termed either 'early fracture

displacement' or 'non-union' if it occurs in the first few weeks after operation. The term 'non-union' is also used for those fractures which fail to heal in later weeks. This normally results in the fracture displacing with loss of position of the fixation device. For this review the term non-union refers to both those fractures which show early displacement plus those which later fail to heal. An incidence of non-union of five to ten per cent can be expected following an undisplaced intracapsular fracture; this rises to about 20 to 40 per cent for displaced intracapsular fractures (Lu-Yao 1994; Parker 1993).

The other main fracture healing complication is avascular necrosis (also termed segmental collapse or femoral head necrosis). This is seen as collapse of the femoral head and subsequent destruction of the hip joint. It occurs secondary to disruption of the blood supply to the femoral head. An incidence of 16 per cent for displaced intracapsular fractures has been reported (Lu-Yao 1994).

Other fracture healing complications that may occur are backing out of the implant as the fracture collapses, fracture below or around the implant and breakage of the implant.

OBJECTIVES

To identify and summarise the evidence from randomised controlled trials of the effects of different implants for the internal fixation of intracapsular proximal femoral fractures.

METHODS

Criteria for considering studies for this review

Types of studies

All randomised controlled trials comparing alternative implants. Quasi-randomised trials (for example, allocation by alternation or date of birth) and trials in which the treatment allocation was inadequately concealed were considered for inclusion. No language restriction was applied.

Types of participants

Skeletally mature patients with an intracapsular proximal femoral fracture.

Types of interventions

Implants used for internal fixation of an intracapsular proximal femoral fracture.

Types of outcome measures

The principal outcome measure was the non-union rate which includes early displacement of the fracture. Data for the following outcomes were sought:

a) Operative details

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

b) Fracture fixation complications

- non-union of the fracture within the follow-up period (the definition of non-union will be that used within each individual study and this outcome will include early re-displacement of the fracture).
 - avascular necrosis
 - fracture below the implant
 - other surgical complications of fixation (as detailed in each study)
 - total fracture fixation complications (sum of the four above outcomes)
 - re-operation (within the follow-up period of the study).
 - superficial wound infection (infection of the wound in which there is no evidence that the infection extends beneath the deep fascia to the site of the implant)
 - deep wound infection (infection around the implant)
 - wound haematoma
- c) Post-operative complications
- pneumonia
 - thromboembolic complications (deep vein thrombosis or pulmonary embolism)
 - any medical complications (as detailed in each individual study)
 - length of hospital stay (in days)
- d) Anatomical restoration
- shortening (as defined in each study)
 - varus deformity (as defined in each study)
 - external rotation deformity (> 20 degrees)
- e) Final outcome measures
- mortality (within the follow-up period of the study)
 - pain (persistent pain at the final follow-up assessment)
 - residence at final follow-up (return to living at home, discharge location)
 - mobility (use of walking aids, return of mobility)
 - regain of activities of daily living
 - health related quality of life measures

Search methods for identification of studies

Electronic searches

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (13 September 2010), the Cochrane Central Register of Controlled Trials (2010, Issue 3), MEDLINE (1950 to August week 5 2010) and EMBASE (1980 to 2010 Week 36). We searched the [WHO International Clinical Trials Registry Platform Search Portal](#), [Current Controlled Trials](#), and the UK [National Research Register \(NRR\) Archive](#) (all to April 2009) to identify ongoing and recently completed trials. No language or publication restrictions were applied.

The generic search strategies for hip fracture trials run in *The Cochrane Library* (Wiley Online Library) and MEDLINE (2002 onwards) are shown in [Appendix 1](#). This MEDLINE search was combined with the sensitivity- and precision-maximizing version of the Cochrane Highly Sensitive Search Strategy for identifying randomized trials ([Lefebvre 2009](#)). The general search strategy for

hip fracture trials in EMBASE (2002 onwards) is also shown in [Appendix 1](#).

Searching other resources

We searched reference lists of articles and our own reference databases. We included the findings from handsearches of the British Volume of the Journal of Bone and Joint Surgery supplements (1996 to 2006), abstracts of the [American Orthopaedic Trauma Association](#) annual meetings (1996 to 2006) and [American Academy of Orthopaedic Surgeons](#) annual meetings (2004 to 2007). We also included handsearch results from the final programmes of SICOT (1996 and 1999) and SICOT/SIROT (2003), EFORT (2007) and the British Orthopaedic Association Congress (2000, 2001, 2002, 2003, 2005 and 2006). Up to 2007, we scrutinised weekly downloads of "Fracture" articles in new issues of *Acta Orthopaedica Scandinavica* (subsequently *Acta Orthopaedica*); *American Journal of Orthopedics*; *Archives of Orthopaedic and Trauma Surgery*; *Clinical Orthopedics and Related Research*; *Injury*; *Journal of the American Academy of Orthopedic Surgeons*; *Journal of Arthroplasty*; *Journal of Bone and Joint Surgery (American and British Volumes)*; *Journal of Orthopedic Trauma*; *Journal of Trauma*; *Orthopedics* from [AMEDEO](#).

Data collection and analysis

Selection of studies

Study selection was performed by one author.

Data extraction and management

Data for the outcomes listed above were independently extracted by both review authors using a data extraction form. Any differences were resolved by discussion.

Assessment of risk of bias in included studies

In the update of the review (2011), two aspects of risk of bias were assessed by one author (MJP) and reported. These were sequence generation and allocation concealment. In this assessment, incomplete or a lack of information on sequence generation or allocation concealment was judged as 'unclear' risk of bias unless the trial was quasi-randomised, in which case both were rated 'no'.

We also independently assessed 11 aspects of methodological quality using a slightly modified scheme to that used in former versions of the review (see [Table 1](#)). There was no masking of the study names or authors. Any differences were resolved by discussion.

Measures of treatment effect

Risk ratios and 95% confidence limits were calculated for dichotomous outcomes, and mean differences and 95% confidence limits calculated for continuous outcomes.

Assessment of heterogeneity

Heterogeneity between comparable trials was assessed by visual inspection of the overlap of confidence intervals amongst included studies and tested using a standard Chi² test.

Data synthesis

Where appropriate, results of comparable groups of trials were pooled using the fixed-effect model. Where there was substantial heterogeneity, the results of the random-effects model were checked and presented.

Sensitivity analysis

We planned but did not undertake sensitivity analyses to investigate the effects of including trials which at risk of bias from lack of allocation concealment.

RESULTS

Description of studies

Thirty studies were included and details of these are given in the [Characteristics of included studies](#). The included studies involve a total of 6334 patients (6339 fractures). [Alho 1998](#) involved three hospitals with different randomisation of implants within each centre. Results for each centre in this study are therefore considered separately under three headings ([Alho 1998\(a\)](#); [Alho 1998\(b\)](#); [Alho 1998\(c\)](#)).

The majority of studies included both undisplaced and displaced fractures. [Kuokkanen 1991](#) included only undisplaced fractures while [Alho 1998](#) ([Alho 1998\(a\)](#); [Alho 1998\(b\)](#); [Alho 1998\(c\)](#)), [Benterud 1997](#), [Christie 1988](#), [Frandsen 1981](#), [Madsen 1987](#) and [Paus 1986](#)

included only displaced fractures. [Dalen 1985](#) did not state the number of displaced fractures.

The types of implant studied differed considerably. Few studies compared the same implants. Details of comparisons can be found in the [Characteristics of included studies](#), and are summarised under each comparison in [Effects of interventions](#).

Four studies ([Ingwersen 1992](#); [Jukkala-Partio 2000](#); [Poulsen 1995](#); [Sernbo 1986](#)) were excluded for the reasons listed in the [Characteristics of excluded studies](#).

The authors of this report would be pleased to receive any additional information from any of the included studies which may then be included in updates of this review.

Risk of bias in included studies

The risk of bias assessments for sequence generation and allocation concealment for individual trials are shown in [Figure 1](#) and an overall summary is given in [Figure 2](#). The majority of judgements were 'unclear', which reflected in part the poor reporting of the methods of randomisation in these trials. Sequence generation was considered adequate in six trials. Only [Lykke 2003](#) was judged as having adequate concealment of allocation. Four quasi-randomised trials ([Harper 1992](#), [Nordkild 1985](#), [Stromquist 1988](#); [Stromqvist 1984](#)) were considered at high risk of bias resulting from both inadequate sequence generation and lack of allocation concealment. Details of the randomisation methods reported in the 30 trials are given below.

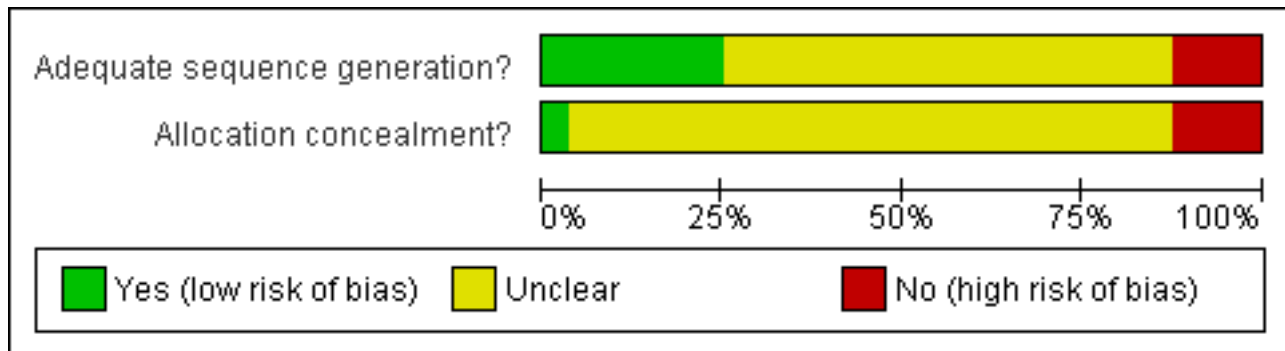
Figure 1. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Adequate sequence generation?	Allocation concealment?
Alberts 1989	?	?
Alho 1998(a)	+	?
Alho 1998(b)	+	?
Alho 1998(c)	+	?
Benterud 1997	?	?
Christie 1988	?	?
Dalen 1985	?	?
Elmerson 1988	?	?
Elmerson 1995	+	?
Frandsen 1981	?	?
Harper 1992	-	-
Herngren 1992	+	?
Holmberg 1990	?	?
Kuokkanen 1991	?	?
Lagerby 1998	?	?
Lindequist 1989	?	?
Lykke 2003	?	+
Madsen 1987	?	?
Mjorud 2006	?	?
Nordkild 1985	-	-
Olerud 1991	?	?
Ovesen 1997	?	?
Parker 2010	+	?
Paus 1986	?	?
Rehberg 1999	+	?

Figure 1. (Continued)

Paus 1986	?	?
Rehnberg 1989	+	?
Sernbo 1990	+	?
Sorensen 1992	?	?
Sorensen 1996	?	?
Stromquist 1988	-	-
Stromqvist 1984	-	-
Svenningsen 1984	?	?
Wihlborg 1990	?	?

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



Lagerby 1998 used closed sealed envelopes drawn in a sequential order. Elmerston 1988 randomised patients from a table of randomised numbers at the time of surgery. Alho 1998 (Alho 1998(a); Alho 1998(b); Alho 1998(c)) used random numbers within closed envelopes. Herngren 1992 and Elmerston 1995 also used a 'random numbers table'. Rehnberg 1989 also used random numbers but also matched for age, sex and type of residence. Wihlborg 1990 used sealed envelopes opened on the day of the operation. Lykke 2003 used sealed opaque numbered envelopes. Mjorud 2006 used sealed numbered envelopes. Paus 1986 used 'coded envelopes' and Sernbo 1990 used a random number generator to randomise the patient in the operating theatre. Parker 2010 used the toss of a coin.

Both Stromquist 1988 and Stromqvist 1984 used open randomisation with odd and even dates of birth. Nordkild 1985 stated they used 'odd and even numbers'. Harper 1992 used the even or odd medical record number.

Alberts 1989, Benterud 1997, Christie 1988, Dalen 1985, Frandsen 1981, Kuokkanen 1991, Lindequist 1989, Madsen 1987, Olerud 1991, Ovesen 1997, Svenningsen 1984, Sorensen 1992, and Sorensen 1996 did not give the method of randomisation. Holmberg 1990 stated that patients were randomised in the operating theatre but did not specify the method used.

The methodological assessment scores for the included studies are shown in Appendix 2.

Effects of interventions

For all the included studies the outcomes measures of non-union, avascular necrosis, total fracture healing complications, re-operations (for arthroplasty or implant removal), mortality and length of surgery are shown in the analysis tables. Data are not available from all included trials on all outcomes. Where significant results are reported in trials, these are also reported here.

Thornton nail versus three Scand pins

Dalen 1985 compared a single Thornton nail with three Scand pins in 94 patients. The limited results presented in the analyses indicate a tendency to a lower failure rate with the Scand pins (Analysis 1.1, Analysis 1.2). Intracapsular pressures were measured for 21 of the cases and showed no difference in intra-operative intra-articular pressures.

Thornton nail versus sliding nail plate

Frandsen 1981 compared a single Thornton nail with a sliding nail plate in 383 patients. Results indicate a lower risk of non-union (Analysis 2.1) for those fractures treated with a sliding nail plate but

no statistically significant difference in avascular necrosis ([Analysis 2.2](#)) or people with either complication ([Analysis 2.3](#)).

Sliding compression screw implant versus McLaughlin nail plate

[Svenningsen 1984](#) compared a sliding compression screw plate implant with a McLaughlin nail plate in 255 patients. Results indicate a tendency towards an increased non-union rate for those treated with the McLaughlin nail plate ([Analysis 3.1](#)). There were no statistically significant differences between the two groups for avascular necrosis ([Analysis 3.2](#)), all fracture healing complications ([Analysis 3.3](#)), re-operations ([Analysis 3.4](#)), infection ([Analysis 3.5](#)) or mortality ([Analysis 3.6](#)). Length of surgery was a mean of 43 minutes for the compression screw implant and 38 minutes for the McLaughlin nail plate ($P < 0.001$). Hospital stay and fall in haemoglobin were reported as showing no significant difference between groups.

Sliding hip screw (SHS) versus sliding nail plate

[Nordkild 1985](#) compared the SHS with the sliding nail plate in 49 patients. Results indicate no difference in the incidence of fracture healing complications ([Analysis 4.1](#), [Analysis 4.2](#)) or re-operations (arthroplasty) ([Analysis 4.3](#)) but an increased number of patients having residual pain in the nail plate group ([Analysis 4.4](#)). Other outcomes reported were range of hip movements and walking aids used which showed no significant difference between groups. Bone scintigraphy was performed in a subgroup of 35 patients and showed no statistically significant difference between groups.

SHS versus double divergent pins

One study of 127 patients compared these implants ([Christie 1988](#)). The results for 15 patients were not given as they had either died early within the follow-up period or had been lost to follow-up. The data for non-union, avascular necrosis, re-operations (all for revision to arthroplasty) and use of walking aids at follow-up are given in the analyses. These results indicate a trend to a lower risk of non-union ([Analysis 5.1](#)) and fewer re-operations ([Analysis 5.4](#)) for those fractures fixed with the double divergent pins but no difference in the other outcomes.

SHS versus different types of cancellous bone screws

Eight studies compared the SHS with different types of cancellous bone screws ([Benterud 1997](#); [Harper 1992](#); [Kuokkanen 1991](#); [Madsen 1987](#); [Ovesen 1997](#); [Paus 1986](#); [Sorensen 1992](#); [Sorensen 1996](#)). The results for the individual comparisons are described separately below but presented together in the analyses: Non-union ([Analysis 6.1](#)), avascular necrosis ([Analysis 6.2](#)), fracture healing complications ([Analysis 6.3](#)), re-operations - arthroplasty ([Analysis 6.4](#)), re-operations - implant removal ([Analysis 6.5](#)), deep wound infection ([Analysis 6.6](#)), mortality ([Analysis 6.7](#)), and pain at follow-up ([Analysis 6.8](#)).

SHS versus Uppsala/ Olmed screws

[Benterud 1997](#) reported a study of 225 patients and found no difference in the incidence of fracture healing complications. [Sorensen 1996](#) reported a study as a conference abstract for 101 patients and found no difference in the total incidence of fracture healing complications. [Ovesen 1997](#) also reported a similar study only as a conference abstract for 316 fractures. The incidence of fracture healing complications for those who attended follow-up

was reported as 31 per cent for the SHS and 25 per cent for Uppsala screws. The difference between these groups was reported as being not statistically significant. Re-operations for arthroplasty were required in 33/108 (30.6%) of SHS cases and 31/117 (26.5%) of the Uppsala group.

[Benterud 1997](#) also reported that two patients in the SHS group developed wound infection requiring debridement. These were classified as deep wound infections in the analyses. [Benterud 1997](#) found no difference between the two groups in mortality nor in pain at follow-up. [Ovesen 1997](#) reported 'no difference' in mortality between groups at three, 12 and 24 months. The average hospital stay was 18 days in the SHS group and 15 days in the Uppsala screws group.

[Benterud 1997](#) reported a significantly reduced median anaesthetic time for Olmed screws of 74 minutes versus 100 minutes for the SHS. Median operative times were 29 versus 55 minutes respectively. [Ovesen 1997](#) reported median operative times of 25 minutes for Uppsala screws and 45 minutes for the SHS. Median operative blood loss was 10 ml for Uppsala screws and 100 ml for the SHS - this was reported as being statistically significant.

SHS versus two von Bahr screws

One study ([Paus 1986](#)) compared the SHS with two von Bahr screws in 131 patients. Results indicate no significant difference in any of the outcomes other than an increased number of patients treated with von Bahr screws who had implant removal ([Analysis 6.5](#)). Length of surgery was also reported as showing a significant increase for the SHS (52 versus 41 minutes, $P < 0.05$).

SHS versus Gouffon screws

[Sorensen 1992](#) compared the SHS with Gouffon screws in 73 patients. The trial was stopped earlier than planned because of the higher fixation failure rate in the Gouffon screw group. Results in the analyses shows a reduced fracture healing complications rate for the SHS (RR 0.52, 95% CI 0.31 to 0.87) but a higher mortality for SHS compared to the Gouffon screws (RR 2.53, 95% CI 1.09 to 5.86).

SHS versus three cancellous screws

[Kuokkanen 1991](#) compared the SHS with three cannulated Mercon screws in 33 patients. Results for non-union, avascular necrosis, re-operations, deep wound infection and mortality are shown in the analyses with no significant difference for the different implants. In addition, there was one case of screw penetration into the acetabulum for the cancellous screw group. It was also reported there was no difference in the length of surgery between groups (61 minutes in each group). Mean operative blood loss was 200 ml for the cancellous screws and 245 ml for the SHS. The surviving patients were assessed by the Harris Hip Score ([Harris 1969](#)) - the results were stated to be 'somewhat better' for the SHS group (3/14 fair or poor for the SHS versus 6/15 for cancellous screws).

[Harper 1992](#) compared the SHS (Ambi screw) with three cancellous screws in 209 patients. Only limited outcomes were reported. The number of cases requiring arthroplasty for fracture healing complications was 9/102 in the SHS group and 11/107 in the cancellous screw group. In addition there were two cases of fracture below the cancellous screws. There was no difference in mortality between groups.

SHS versus four cancellous screws

Madsen 1987 compared the SHS with four cancellous AO screws in 103 patients. Results for non-union of the fracture were presented using an actuarial survival analysis from which it was not possible to determine the number of patients who had died, been lost to follow-up or developed non-union. The paper reported a two-year cumulated union rate of 64 per cent for the SHS and 84 per cent for the parallel screw group, a difference that was reported as being statistically significant ($P < 0.05$). Results for avascular necrosis, re-operations and deep wound infection given in the analyses show no significant differences.

Madsen 1987 also reported on length of surgery which was a mean of 130 minutes for the SHS and 108 minutes for the parallel screws. Figures for the mean operative blood loss were 350 ml versus 200 ml for the cases of SHS and parallel screws who had a general anaesthetic and 200 ml versus 150 ml for those who had a regional anaesthetic. All these differences between groups were significantly in favour of the cancellous screws. Bone scintigraphy was also measured in 87 cases in Madsen 1987. The number of femoral heads with an impaired uptake was 14/40 for the SHS and 5/47 for the cancellous screws, a difference that was reported to be statistically significant.

Two von Bahr screws versus Hessel pins

Lindequist 1989 compared von Bahr screws with Hessel pins for 150 patients. All the results of this study are presented in the analyses (Analysis 7.1 to Analysis 7.8) and indicate a reduction in fracture healing complications (RR 0.58, 95% CI 0.40 to 0.83, Analysis 7.3) and re-operations (RR 0.47, 95% CI 0.28 to 0.79, Analysis 7.4; RR 0.26, 95% CI 0.10 to 0.66, Analysis 7.5) for the von Bahr screws.

Two von Bahr screws versus Gouffon screws

Lindequist 1989 compared von Bahr screws with Gouffon screws in 169 patients. All the results of this study are presented in the analyses (Analysis 8.1 to Analysis 8.8) and indicate no significant difference in the incidence of fracture healing complications but a reduction in re-operations for implant removal (Analysis 8.5) for the von Bahr screws.

Two von Bahr screws versus two Uppsala screws

One study of 222 patients compared these two implants (Rehnberg 1989). Results indicate a higher risk of non-union and fracture healing complications for the von Bahr screws (RR 3.18, 95% CI 1.70 to 5.94, Analysis 9.1; RR 2.17, 95% CI 1.32 to 3.55, Analysis 9.3). In addition to the complications shown in the analyses there were two cases of screw penetration in the Uppsala group and one in the von Bahr group. Other outcomes reported were for mortality (Analysis 9.6), mean length of surgery and mean operative blood loss for which there was no significant difference between groups. Pain was assessed at four and 12 months and reported to be significantly reduced for those treated with Uppsala screws ($P < 0.001$ at 4 months, $P < 0.01$ at 12 months). Use of walking aids was reported to be significantly more common ($P < 0.01$) after von Bahr screws at four months, but no significant difference was noted at 12 months. There was no significant difference in the change in residential status between groups for four and 12 months.

Three Richard screws versus two Uppsala screws

Lagerby 1998 studied 268 fractures in 266 patients. Results for non-union (Analysis 10.1), avascular necrosis (Analysis 10.2), fracture healing complications (Analysis 10.3) and pain at follow-up (Analysis 10.4) show no significant difference between the two implants. Re-operations, mortality and use of walking aids were reported as showing 'no difference' between groups.

Three Ullevaal screws versus two Olmed screws

Alho 1998(a) and Alho 1998(c) compared three Ullevaal screws with two Olmed screws in 358 patients. The limited results as presented in the analyses show a lower re-operation rate for conversion to arthroplasty for those patients treated at Ullevaal hospital (Alho 1998(c); RR 0.42, 95% CI 0.22 to 0.83, Analysis 11.1). No difference in this re-operation rate was seen at the other centre (Alho 1998(a)). There was no difference between the two interventions in the implant removal rate (Analysis 11.2). Three patients in the Ullevaal screw group and one in the Olmed screw group suffered fracture below the screws, necessitating revision fixation (Analysis 11.3). No other outcomes were reported.

Three Ullevaal screws versus two Tronzo screws

Alho 1998(b) compared three Ullevaal screws with two Tronzo screws in 249 patients. The limited results, as presented in the analyses, indicate no difference in the number of patients needing conversion to arthroplasty (Analysis 12.1), but a tendency to a lower removal of the implant for the Tronzo screws, although the result did not reach statistical significance (RR 2.05, 95% CI 0.90 to 4.66, Analysis 12.2). One patient in the Ullevaal screw group suffered fracture below the screws, necessitating revision fixation (Analysis 12.3). No other outcomes were reported.

Three screws of any type versus two screws of any type

Exploratory analysis was undertaken to combine all studies which compared three screws with two screws (Alho 1998(a); Alho 1998(b); Alho 1998(c); Lagerby 1998). Results as indicated in the analyses (Analysis 13.1 to Analysis 13.8) show no significant difference between three or two screws except for re-operation for arthroplasty. For this outcome there was a significant reduction for the three screws (32/302 versus 52/305; RR 0.64, 95% CI 0.43 to 0.97, Analysis 13.4). However, when those cases of non-union in Lagerby 1998 are considered as well, the difference in major fracture healing complications between three and two screws becomes statistically insignificant (Analysis 13.7).

Three short threaded AO screws versus three long threaded AO screws

Parker 2010 compared three AO screws with 16 mm of threads with three AO screws of 32 mm threads in 432 patients. Results as presented in the analyses showed no statistically significant differences in the occurrence of fracture healing complications (Analysis 14.1, Analysis 14.2, Analysis 14.3), re-operations (Analysis 14.4, Analysis 14.5), mortality (Analysis 14.6), residual pain (Analysis 14.7) or change in residential status (Analysis 14.8) between the two methods of fixation. In addition there was no difference between groups for the regain of mobility and mean pain scores at one year from injury.

Three Scand screws versus three Nystrom nails

Alberts 1989 compared three Nystrom nails with three Scand screws in 133 patients. Results as presented in the analyses showed no difference for fracture healing complications (Analysis 15.1, Analysis 15.2, Analysis 15.3), infection (Analysis 15.4, Analysis 15.5) and mortality (Analysis 15.6, Analysis 15.7). Extrusion of the implant was more common with the Nystrom nails. Mean length of surgery was 18 minutes for the Nystrom nails and 30 minutes for the Scand screws (P value reported as < 0.001).

Three Gouffon screws with a Rydell four-flanged nail

Two studies compared these two implants. Elmerston 1988 reported a study of 223 patients and Wihlborg 1990 a study of 200 patients. Results as presented in the analyses showed no difference between the two implants for the outcome measures of non-union (Analysis 16.1), avascular necrosis (Analysis 16.2), fracture healing complications (Analysis 16.3), re-operations (for arthroplasty) (Analysis 16.4), infection (Analysis 16.5, Analysis 16.6) or mortality (Analysis 16.7, Analysis 16.8).

Elmerston 1988 also indicated that the mean length of surgery was 38 minutes for Gouffon screws and 28 minutes for the Rydell nail, a difference that was reported to be statistically significant (P < 0.001).

Two Hansson pins versus a Rydell four-flanged nail

Three studies compared these implants: Holmberg 1990 reported a study of 220 patients; Sernbo 1990 of 410 patients and Stromqvist 1984 of 152 patients. The outcomes measures, where reported, for non-union (Analysis 17.1), avascular necrosis (Analysis 17.2), fracture healing complications (Analysis 17.3), re-operations (Analysis 17.4, Analysis 17.5) and mortality at two years (Analysis 17.6) are shown in the analyses. Results indicated no significant difference in outcomes between the two implants for any of the outcomes listed above; the random-effects model was used for the first five analyses because of clearly significant heterogeneity.

Holmberg 1990 reported that a similar number of patients in each group (27/110 and 26/110) failed to return to the same residential status. Sernbo 1990 also gave figures for the mean length of surgery, radiographic screening time, length of hospital stay and numbers going back to the same residential state. There was no significant difference between groups for any of these outcomes. Stromqvist 1984 reported no cases of deep wound infection in either group and also presented the results of bone scintimetric evaluation for 138 of the patients. This indicated a statistically significant reduction of uptake of isotope for those fractures treated with the four-flanged nail.

Two Hansson pins versus Sliding Hip Screw (SHS)

Both Elmerston 1995 (222 patients) and Sorensen 1996 (99 patients) found no difference in the incidence of fracture healing complications (Analysis 18.1, Analysis 18.2, Analysis 18.3), or re-operations (Analysis 18.4). Mortality was reported in Elmerston 1995 with no difference between implants (Analysis 18.5). Elmerston 1995 also reported on the length of surgery, which was significantly lower for the Hansson pins (24 versus 34 minutes, Analysis 18.6).

Two Hansson hook pins versus cancellous screws

Six studies compared two Hansson hook pins with different types of cancellous bone screws (Herngren 1992; Lykke 2003; Mjorud 2006; Olerud 1991; Sorensen 1996; Stromqvist 1988). The results for the individual comparisons are described separately below but presented together in the analyses: Non-union (Analysis 19.1), avascular necrosis (Analysis 19.2), fracture healing complications (Analysis 19.3), re-operations - arthroplasty (Analysis 19.4), re-operations - arthroplasty or need for arthroplasty (Analysis 19.5), re-operations - implant removal (Analysis 19.6), re-operations - type not specified (Analysis 19.7), deep wound infection (Analysis 19.8), superficial wound infection (Analysis 19.9), and mortality (Analysis 19.10).

Two Hansson pins versus two Uppsala screws

Three studies compared these implants: Herngren 1992 (179 patients, 180 fractures), Olerud 1991 (115 patients) and Sorensen 1996 (100 patients). Pooled results using the random-effects model for non-union, avascular necrosis and all fracture healing complications show no significant differences between the two implants. Notably, Olerud 1991 reported a significant reduction in the incidence of non-union for those treated with the Uppsala screws (RR 3.79, 95% CI 1.51 to 9.53), while the two trials (Herngren 1992; Sorensen 1996) found no difference between implants for the incidence of fracture healing complications. Herngren 1992 also reported three cases of trochanteric fracture of the same hip in those treated with the Hansson pins and one case with Uppsala screws. Pooled data for mortality from two trials showed trend to lower mortality in the Hansson pin group.

Length of surgery reported by Herngren 1992 was a mean of 33 minutes for the Hansson pins and 38 minutes for the Uppsala screws.

Olerud 1991 also reported, without figures, that at the four and 12 month follow-up there was a statistically significant increased incidence of pain (P = 0.0007 at 4 months, P = 0.007 at 12 months), failure to regain residential status (P = 0.028 at 4 months, P = 0.03 at 12 months) and reduction in mobility (P = 0.008 at 4 months, P = 0.097 at 12 months) for those treated by the Hansson pins.

Herngren 1992 noted there was local discomfort to lateral protrusion of the implant in six out of 96 Uppsala screw cases but in no patients of the Hansson group.

Two Hansson hook pins versus two AO screws

Stromqvist 1988 studied 110 cases. Follow-up of patients was for only four months and the trial methodology was poor. Non-union and avascular rates were not given but re-operations within the follow-up period were stated as fewer for the Hansson pins. However, it was reported that more patients in the Hansson pin group were scheduled for arthroplasty, such that the difference between groups for those who had re-operations and needed re-operation was not significantly different (Analysis 19.5). Mortality and bone scintimetry results showed no significant difference between the two implants.

Two Hansson hook pins versus three AO screws

Mjorud 2006 studied 199 cases. Follow-up of patients was for two years. Outcomes reported and detailed in the analyses were fracture healing complications and re-operations. None of these

outcomes showed any difference between groups. Mean length of surgery was 36 minutes for the Hansson pins and 40 minutes for the AO screws, a difference that was reported as not statistically significant. Mortality reported at up to two years from surgery showed no difference between groups. Other outcomes reported which also showed no statistically significant difference between groups were inability to walk at discharge and later walking ability.

Two Hansson hook pins versus three Ullevaal screws

Lykke 2003 compared two Hansson pins with three Ullevaal screws in 278 fractures. Results as indicated in the analyses show no significant difference in non-union, fracture healing complications, re-operations, wound infections or mortality between treatment groups. There appeared, however, a potential trend to a lower rate of avascular necrosis in the Hansson pin group. In addition the study reported there was no differences in the degree of residual pain at follow-up between groups (31% versus 23%), mean or median length of hospital stay (12 versus 10 days, 8 versus 8 days), or proportion of patients discharged to rehabilitation homes (47% versus 49%). The complication of deep vein thrombosis was similar between groups (one in each) as was that from pneumonia (one in the Hansson pin group versus three in the Ullevaal group). Fracture healing complications were more common in those cases in which drill penetration into the hip joint occurred during surgery. Drill penetration was more common in the Ullevaal screw group (7 versus 16 cases).

DISCUSSION

Thirty studies using a wide variety of orthopaedic implants were identified and included within the analysis. The methodology of the studies varied considerably and most trials scored poorly, although in some of these cases the low score may reflect a poor reporting of trial methods rather than poor trial methodology. Additionally, risk of bias assessment relating to sequence generation and allocation concealment found only six trials were at low risk of bias for the first item and only one trial at low risk of bias for the second. The main outcome measures reported were fracture healing complications, re-operations and mortality. The reporting of functional outcomes was poor and only documented in a small number of studies. The few significant differences observed after multiple analyses may have arisen by chance. Taken in conjunction with the generally low methodological quality of the studies as reported, caution needs to be adopted in drawing any definite conclusions. Most of the reported trials enrolled less than 300 participants. Thus, they were likely to be underpowered to provide evidence of significant difference between devices unless these differences had been expected to be large. Biologically or mechanically plausible differences between devices compared, and thus the hypotheses apparently being tested in the trials, were often unclear.

A significant potential for bias within the studies may have occurred in those centres which were evaluating an implant that was developed in their own institution, or by one of the authors of the study. The studies concerned were for Hansson pins (Stromqvist 1984), Uppsala screws (Olerud 1991; Rehnberg 1989), sliding compression screw plate (Svenningsen 1984) and Ullevaal screws (Alho 1998(c)). All these reported better outcomes for their own implants. The problems are highlighted in Alho 1998 who recommends that evaluation of implants by centres with a particular interest or expertise in one of the implants, is strongly

prone to biases even within the context of a randomised trial. The cause for these biases is difficult to explain.

The conclusions for the different implants are summarised in the following.

Double divergent pins; fixed (static) nail plate; sliding compression screw plate; Hessel pins and Nystrom nails

For all these implants, only one randomised trial was found evaluating each implant (Alberts 1989: Nystrom nails; Christie 1988: double divergent pins; Lindequist 1989: Hessel pins; Svenningsen 1984: fixed nail plate and sliding compression screw plate). None of these studies showed a clear difference between the implants under investigation. Therefore, no conclusions can be made for the use of these implants from the randomised trials undertaken to date.

Single Thornton nail

This implant was found to have been evaluated in two randomised studies; one against three cancellous screws (Dalen 1985) and another against a sliding nail plate (Frandsen 1981). Both studies reported a tendency to a lower risk of fracture healing complications with the comparison implant. While there are limited data on the use of this implant, its use cannot be recommended given the tendency to inferior results in both comparisons.

Sliding nail plate

This implant has been evaluated in two randomised studies, one against a single Thornton nail (Frandsen 1981), where a lower rate of non-union was found for the nail plate, and the other against an SHS (Nordkild 1985), where more patients had residual pain in the nail plate group. However, the small number of patients evaluated within these two trials means that no definite conclusions can be made regarding the use of a sliding nail plate.

Rydell four-flanged nail

This implant was found to have been evaluated in five randomised studies, two comparing against Gouffon pins (Elmerson 1988; Wihlborg 1990) and three studies comparing against Hansson pins (Holmberg 1990; Sernbo 1990; Stromqvist 1984). No difference for the incidence of fracture healing complications or mortality between groups was found. As exception was found for Stromqvist 1984, where the results favoured the Hansson pin but, as stated already, this trial is potentially biased given the implant had been developed in the same institution.

Hansson hook (LIH) pins

This implant has been evaluated in 10 randomised trials. Bias may have occurred in these studies, possibly due to greater experience with one of the implants under investigation. A strong trend to improved outcomes with the Hansson pins was found in the study from Lund, Sweden (Stromqvist 1984), where the pins were developed by one of the paper's authors. The study from Uppsala, Sweden (Holmberg 1990) was from a unit where the Rydell nail was the implant used before the start of the study. This study showed a tendency to lower complications with the Rydell nail. A study from Uppsala (Olerud 1991) compared Hansson pins with Uppsala screws and found better outcomes with the latter group. The difference in results between studies may therefore be due to

familiarity or special expertise with the use of one of the implants under investigation.

Three studies compared Hansson pins with the Rydell nail (Holmberg 1990; Sembo 1990; Stromqvist 1984). Although, as described above, Stromqvist 1984 showed better outcomes after the Hansson pins, overall there were no notable differences between implants. Three studies compared Hansson pins with Uppsala screws (Herngren 1992; Olerud 1991; Sorensen 1996), two with two AO screws (Mjorud 2006; Stromqvist 1988), one with Ullevaal screws (Lykke 2003) and two with the SHS (Elmerson 1995; Sorensen 1996). Overall there were no notable differences in fracture healing complications between implants.

Sliding hip screw (SHS)

This implant has been evaluated more extensively within 11 randomised studies. Christie 1988 compared the SHS with double divergent pins. There was a tendency to lower fracture healing complications after double divergent pins, but due to the low numbers of patients reported, no definite conclusions can be made about the comparison of these two implants. Nordkild 1985 compared the SHS with the sliding nail plate. Results indicated no difference in the incidence of fracture healing complications, but more patients had residual pain in the nail plate group. Two studies compared the SHS with Hansson pins (Elmerson 1995; Sorensen 1996). Neither study found any significant difference in the incidence of fracture healing complications.

Eight studies compared the SHS with different types of cancellous bone screws (Benterud 1997; Harper 1992; Kuokkanen 1991; Madsen 1987; Ovesen 1997; Paus 1986; Sorensen 1992; Sorensen 1996). Summation of results showed an increased incidence of avascular necrosis and also a tendency to a higher fixation failure rate with the cancellous screws, although the overall re-operation rate for fixation failure did not differ between implants. Those studies that reported on operative blood loss and operative time noted an increase for the SHS. The findings of a significantly higher mortality in the SHS group of Sorensen 1992 were not found in the other five trials providing data for this outcome.

Multiple screws

Implants consisting of multiple screws were the most prevalent type of implant studied. Eighteen studies compared a multiple parallel screw technique against an alternative type of implant. As summarised above, for those studies that compared multiple screws against the SHS (Benterud 1997; Harper 1992; Kuokkanen 1991; Madsen 1987; Ovesen 1997; Paus 1986; Sorensen 1992; Sorensen 1996), there was no overall difference in the number of fracture healing complications between implants aside from an increased incidence of avascular necrosis for the screws, but some studies noted that the SHS fixation took longer and had an

increased blood loss. For those studies, which compared parallel screws with another type of implant, no study demonstrated notable differences for these comparisons. These studies were those comparing Gouffon screws with the Rydell nail (Elmerson 1988; Wihlborg 1990), Uppsala/Olmed screws with Hansson pins (Olerud 1991; Sorensen 1996; Herngren 1992), AO screws with Hansson pins (Mjorud 2006; Stromqvist 1988), Ullevaal screws with Hansson pins (Lykke 2003), Scand hip pins with the Thornton nail (Dalen 1985), Scand hip pins with Nystrom nails (Alberts 1989) and von Bahr screws with Hessel pins (Lindequist 1989).

A further five studies compared different screw types (Alho 1998 (Alho 1998(a); Alho 1998(b); Alho 1998(c)); Lagerby 1998; Lindequist 1989; Rehnberg 1989; Parker 2010). For these studies it was not possible to make any notable conclusions between the different screw types affecting the incidence of fracture healing complications. This included those studies which compared two versus three screws.

AUTHORS' CONCLUSIONS

Implications for practice

There is insufficient evidence from randomised controlled trials to determine the best implant for internal fixation of intracapsular fractures.

Implications for research

Further studies are required to determine the choice of implant for internal fixation of intracapsular fractures. Future studies should be adequately powered to detect any clinically important difference between implant types; in the light of the evidence from this review, they may require recruiting thousands rather than hundreds of participants, and to be multi-centre in order to increase generalisability and avoid biases which may have arisen in the past from single centre studies. These trials should have appropriate methodology with a minimum of one year follow-up of cases and always report the results in full, even if the difference between implants is not significant. The current ongoing multi-centre FAITH trial (FAITH) does address these issues and is comparing the two most commonly used implants of the SHS and multiple screws.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Alberts 1989

Methods	Method of randomisation: not stated Number lost to follow-up: 0 Length of follow-up: 24 months
Participants	Orthopaedic unit in Stockholm, Sweden 133 patients with an intracapsular fracture. 65% of fractures were displaced

Internal fixation implants for intracapsular hip fractures in adults (Review)

Alberts 1989 (Continued)

Mean age: 77 years (range 39 to 99)
 % male: 30%

Interventions	Three Nystrom nails versus three Scand screws. Nystrom nails are 6.5 mm smooth pins Scand pins are 6.5 mm cancellous threaded screws
Outcomes	Length of surgery Non-union Avascular necrosis Screw penetration Breakage of implant Superficial wound infection Deep wound infection Mortality (one and two years)
Notes	The results for 15 patients entered in the study were not given as they had either 'early death' or were lost to follow-up.

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Alho 1998(a)

Methods	Method of randomisation: "random numbers in closed envelopes" Number lost to follow-up: 6/607 (1%) - this is the total number for the three studies of Alho Length of follow-up: 24 months
Participants	Orthopaedic unit in Rogaland Central Hospital, Norway (one of three centres in a multicentre study) 191 patients with an intracapsular fracture. % of fractures displaced: 100% Mean age: Median 79 years (range 54 to 97) % male: 22%
Interventions	Two Olmed screws versus three Ullevaal screws Olmed screws are the same as Uppsala screws with a 6 mm shank and 8 mm threads Ullevaal screws are 7 mm shank and 7 mm cancellous threaded screws
Outcomes	Re-operations - arthroplasty Re-operations - implant removal Fracture below the screws
Notes	One of three centres in a multicentre study. Results for the three centres are presented separately and there was a significant difference in the characteristics of patients and re-operations between centres as detailed in Alho 1998 . Patients at Ullevaal hospital were older, those at Rogaland were more likely to live in residential accommodation and more re-operations were undertaken at Rogaland hospital

Risk of bias

Alho 1998(a) (Continued)

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	"Random numbers"
Allocation concealment?	Unclear risk	"Closed envelopes"

Alho 1998(b)

Methods	Method of randomisation: "random numbers in closed envelopes" Number lost to follow-up: 6/607(1%) - this is the total number for the three studies of Alho Length of follow-up: 24 months
Participants	Orthopaedic unit in Akeershus, Norway (one of three centres in a multicentre study) 249 patients with an intracapsular fracture. % of fractures displaced: 100% Mean age: median 78 years (range 54 to 96) % male: 18%
Interventions	Three Ullevaal screws versus two Tronzo screws Tronzo (VLF) screws are cancellous screws with a sliding capacity to allow for collapse at the fracture site; Ullevaal screws are 7 mm shank and 7 mm cancellous threaded screws
Outcomes	Re-operations - arthroplasty Re-operations - implant removal Fracture below the screws
Notes	One of three centres in a multicentre study. Results for the three centres are presented separately and there was a significant difference in the characteristics of patients and re-operations between centres as detailed in Alho 1998 . Patients at Ullevaal hospital were older, those at Rogaland were more likely to live in residential accommodation and more re-operations were undertaken at Rogaland hospital.

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	"Random numbers"
Allocation concealment?	Unclear risk	"Closed envelopes"

Alho 1998(c)

Methods	Method of randomisation: "random numbers in closed envelopes" Number lost to follow-up: 6/607(1%) - this is the total number for the three studies of Alho Length of follow-up: 24 months
Participants	Orthopaedic unit in Ullevaal Hospital, Norway (one of three centres in a multicentre study) 167 patients with an intracapsular fracture. % of fractures displaced: 100% Mean age: median 81 years (range 56 to 97)

Internal fixation implants for intracapsular hip fractures in adults (Review)

Alho 1998(c) (Continued)

% male: 22%

Interventions	Two Olmed screws versus three Ullevaal screws Olmed screws are the same as Uppsala screws with a 6 mm shank and 8 mm threads; Ullevaal screws are 7 mm shank and 7 mm cancellous threaded screws
Outcomes	Re-operations - arthroplasty Re-operations - implant removal Fracture below the screws
Notes	One of three centres in a multicentre study. Results for the three centres are presented separately and there was a significant difference in the characteristics of patients and re-operations between centres as detailed in Alho 1998 . Patients at Ullevaal hospital were older, those at Rogaland were more likely to live in residential accommodation and more re-operations were undertaken at Rogaland hospital

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	"Random numbers"
Allocation concealment?	Unclear risk	"Closed envelopes"

Benterud 1997

Methods	Method of randomisation: not stated Number lost to follow-up: not stated Length of follow-up: median 39 months (range 22 to 51)
Participants	Orthopaedic unit in Ullevaal, Norway 225 patients with an intracapsular fracture. % of fractures displaced: 100% (all displaced) Mean age: median 81 years (range 63 to 97) % male: 21%
Interventions	Sliding hip screws supplemented with a parallel cancellous screw versus two Olmed screws Olmed screws are the same as Uppsala screws with a 6 mm shank and 8 mm threads
Outcomes	Length of surgery Operative blood loss Non-union Avascular necrosis Re-operations Wound infection Mortality (three months)
Notes	The results for 1 patient who received the wrong implant were not included

Risk of bias

Bias	Authors' judgement	Support for judgement
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Benterud 1997 (Continued)

Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Christie 1988

Methods	Method of randomisation: not stated Number lost to follow-up: 8 (6.3%) Length of follow-up: mean 33 months
Participants	Orthopaedic unit in Edinburgh, Scotland, UK 127 patients with a displaced intracapsular fracture All fractures were displaced Mean age: 69 years (range 26 to 80) % male: not stated
Interventions	Sliding hip screw fixation or double divergent pins
Outcomes	Non-union Avascular necrosis Re-operation rate Use of walking aids
Notes	The results for 15 patients entered in the study were not given as they had either 'early death' or were lost to follow-up.

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Dalen 1985

Methods	Method of randomisation: not stated Number lost to follow-up: 9 (8.7%) Length of follow-up: mean 12.6 months
Participants	Orthopaedic unit in Danderyd, Sweden 94 patients with an intracapsular fracture. % of fractures displaced: not stated Mean age: 79 years (range 68 to 90) % male: 24%
Interventions	Thornton nail versus three Scand pins The Thornton nail is a flanged trifin cannulated nail Scand pins are 6.5 mm cancellous threaded screws
Outcomes	Non-union Re-operation

Dalen 1985 (Continued)

Intra-articular pressure

Notes

The results for 9 patients were not given because of 'technical failure of abnormalities of the opposite hip.'

The report of Jacobsson relates to the intraarticular pressures for 21 of the patients

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Elmerson 1988

Methods

Method of randomisation: "by the surgical nurse at the time of surgery according to a table of random numbers"

Number lost to follow-up: 9(4%)

Length of follow-up: 24 months

Participants

Orthopaedic unit in Gothenburg, Sweden

223 patients with an intracapsular fracture.

74% of fractures were displaced

Mean age: 77 years (range 18 to 98)

% male: 30%

Interventions

Three Gouffon screws versus Rydell nail

Gouffon screws are 6.5 mm cancellous screws

Rydell nail is a four flanged nail with a hook extruded at its tip

Outcomes

Length of surgery

Non-union

Avascular necrosis

Superficial wound infection

Deep wound infection

Mortality (one and two years)

Notes

The results for 20 patients entered in the study were not given as they had died within three months of fracture. No fracture healing complications were reported in this group. In 16 cases the fracture was not reducible and these were excluded as treated by a prosthesis.

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	"by the surgical nurse at the time of surgery according to a table of random numbers"
Allocation concealment?	Unclear risk	"by the surgical nurse at the time of surgery according to a table of random numbers"

Elmerson 1995

Methods	Method of randomisation: "random number table" Number lost to follow-up: 3 (1.2%) Length of follow-up: mean 24 months
Participants	Orthopaedic unit in Sahlgren Hospital, Gothenburg, Sweden 222 patients with an intracapsular fracture. 55% of fractures were displaced Mean age: 77 years (range 50 to 94) % male: 31%
Interventions	Sliding hip screw versus two Hansson hook pins (LIH pins) Hansson hook pins are 6.5 mm diameter smooth pins with a hook which is extruded at its tip
Outcomes	Length of surgery Non-union Avascular necrosis Re-operations for arthroplasty Mortality (two years)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	"random number table"
Allocation concealment?	Unclear risk	not stated

Frandsen 1981

Methods	Method of randomisation: not stated Number lost to follow-up: 21 (5.4%) Length of follow-up: median 25 and 32 months (range median 24 to 65 months)
Participants	Orthopaedic unit in Odense, Denmark 383 patients with an intracapsular fracture. 100% of fractures were displaced Median age: 78 years (range 22 to 96) % male: 22%
Interventions	Thornton nail versus sliding nail plate The Thornton nail is a flanged trifin cannulated nail The sliding nail plate is similar to a sliding hip screw but has flanges instead of a lag screw. The nail is connected to the plate with a bolt
Outcomes	Non-union Avascular necrosis
Notes	The 1979 paper was a preliminary result of the study. The Thornton nail plate fixation was referred to in the paper as Smith-Petersen osteosynthesis. Study involved displaced fractures only

Frandsen 1981 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Harper 1992

Methods	Method of randomisation: by even or odd numbers of patient record Number lost to follow-up: not stated Length of follow-up: 18 months
Participants	Orthopaedic unit in Leicester, England 209 patients with an intracapsular fracture. 83% of fractures were displaced Mean age: 72 years (range 25 to 93) % male: 26%
Interventions	Sliding hip screw (Ambi hip screw) versus three parallel cannulated cancellous screws (Richards Medical)
Outcomes	Fracture healing complications Mortality - 1 year
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	High risk	"the last digit of the patients accident and emergency number"
Allocation concealment?	High risk	"the last digit of the patients accident and emergency number"

Herngren 1992

Methods	Method of randomisation: by "sequence of random numbers" Number lost to follow-up: 5 (2.8%) Length of follow-up: 12 months
Participants	Orthopaedic unit in Ostersund, Sweden 180 fractures in 179 patients with an intracapsular fracture. 72% of fractures were displaced Mean age: 78 years (range 28 to 97) % male: 37%
Interventions	Two Uppsala screws versus two Hansson pins Uppsala screws are 8 mm cancellous screws with a 6mm shank Hansson hook pins are 6.5 mm diameter smooth pins with a hook which is extruded at its tip

Herngren 1992 (Continued)

Outcomes	Length of surgery Non-union Avascular necrosis Later trochanteric fracture Re-operations Local discomfort Deep wound infection Mortality (one year)
Notes	One fracture could not be reduced and was excluded as treated by a prosthesis.

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	"Sequence of random numbers"
Allocation concealment?	Unclear risk	"Sequence of random numbers"

Holmberg 1990

Methods	Method of randomisation: "in the operating theatre". Exact method not stated Number lost to follow-up: 5 (2.3%) Length of follow-up: 24 months
Participants	Orthopaedic unit in Uppsala, Sweden 220 patients with an intracapsular fracture. 65% of fractures were displaced Mean age: 79 years (range 40 to 98) % male: 25%
Interventions	Rydell four flanged nail versus two Hansson hook pins (LIH pins) Rydell nail is a four flanged nail with a hook extruded at its tip Hansson hook pins are 6.5 mm diameter smooth pins with a hook which is extruded at its tip
Outcomes	Non-union Avascular necrosis Re-operations for arthroplasty Re-operations for implant removal Mortality at 2 years Failure to return home
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	"in the operating theatre". Exact method not stated
Allocation concealment?	Unclear risk	"in the operating theatre". Exact method not stated

Kuokkanen 1991

Methods	Method of randomisation: not stated Number lost to follow-up: 0 Length of follow-up: mean 24 months (range 17 to 35 months)
Participants	Orthopaedic unit in Helsinki, Finland 33 patients with an intracapsular fracture. % of fractures displaced: none (all undisplaced) Mean age: 66 years (range 21 to 84) % male: not stated
Interventions	Sliding hip screw versus three cannulated cancellous screws (Mercon) Mercon screws are 6.5 mm cancellous threaded screws
Outcomes	Non-union Avascular necrosis Screw penetration Re-operations - arthroplasty Re-operations - implant removal Deep wound infection Length of surgery Operative blood loss Mortality Harris hip score

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Lagerby 1998

Methods	Method of randomisation: "in block of four using a closed envelope system. The envelopes were drawn in sequential order" Number lost to follow-up: 28 (10.4%) Length of follow-up: 12 months
Participants	Orthopaedic unit in Vasteras, Sweden 268 fractures in 266 patients with an intracapsular fracture. 72% of fractures were displaced Mean age: 80 years (range 31 to 99) % male: 33%
Interventions	Three Richards screws versus two Uppsala screws Richards screws are 4.8 mm shaft and 6.86 mm thread diameter Hansson hook pins are 6.5 mm diameter smooth pins with a hook which is extruded at its tip
Outcomes	Non-union Avascular necrosis Screw penetration

Lagerby 1998 (Continued)

Re-operations - arthroplasty
 Mortality
 Pain
 Use of walking aids

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	"in block of four using a closed envelope system. The envelopes were drawn in sequential order"
Allocation concealment?	Unclear risk	"in block of four using a closed envelope system. The envelopes were drawn in sequential order"

Lindequist 1989

Methods	Method of randomisation: not stated Number lost to follow-up: 6 (2.7%) Length of follow-up: 24 months
Participants	Orthopaedic unit in Galve, Sweden 220 patients with an intracapsular fracture. 80% of fractures were displaced Mean age: 77 years (range 32 to 97) % male: 29%
Interventions	Gouffon pins versus von Bahr screws versus Hessel pins Number of screws/pins used not stated Gouffon pins are 6.5 mm cancellous screws von Bahr screws are 7 mm cancellous screws with a 5.5 mm shank Hessel pins are 6.5 mm diameter smooth pins
Outcomes	Non-union Avascular necrosis Superficial wound infection Deep wound infection Re-operations - arthroplasty Re-operations - implant removal Mortality (two years)
Notes	The study was in two parts. Firstly von Bahr screws versus Hessel pins and then von Bahr screws versus Gouffon screws. Results of von Bahr screws for the two parts were presented together. The paper reported that there was no difference in the failure rate for the screws between the first and second parts

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Internal fixation implants for intracapsular hip fractures in adults (Review)

Lykke 2003

Methods	Method of randomisation: "numbered sealed opaque envelopes in blocks of 50" Number lost to follow-up: not stated Length of follow-up: 24 months
Participants	Orthopaedic unit in Oslo, Norway 278 intracapsular fracture. 72% of fractures were displaced Mean age: 82 years (range 27 to 101) % male: 18%
Interventions	Two Hansson hook-pins versus three Ullevaal hip screws Hansson hook pins are 6.5 mm diameter smooth pins with a hook which is extruded at its tip Ullevaal screws are 7 mm shank and 7 mm cancellous threaded screws
Outcomes	Non-union and early fracture displacement Avascular necrosis Re-operations - arthroplasty Superficial wound sepsis Deep wound sepsis Wound haematoma Deep vein thrombosis Pneumonia Mortality - up to two years Pain Return to the same residential status Length of hospital stay (mean or median) Drill penetration of the femoral head
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	"numbered sealed opaque envelopes in blocks of 50"
Allocation concealment?	Low risk	"numbered sealed opaque envelopes in blocks of 50"

Madsen 1987

Methods	Method of randomisation: not stated Number lost to follow-up: not stated Length of follow-up: 24 months
Participants	Orthopaedic unit in Esbjerg, Denmark 103 patients with an intracapsular fracture. 100% of fractures were displaced Mean age: 74 years (range 25 to 92) % male: 24%
Interventions	Sliding hip screw versus four AO cancellous screws AO screws are have 6.5 mm cancellous threads

Madsen 1987 (Continued)

Outcomes	Length of surgery Operative blood loss Non-union and early fracture displacement Avascular necrosis Re-operations - arthroplasty Re-operations - removal Deep wound infection Bone scintigraphy
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Notes	The 1986 paper related solely to the results of bone scintigraphy for 87 of the patients One patient died after randomisation and before surgery
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Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Mjorud 2006

Methods	Method of randomisation: "in blocks of 50 with sealed numbered envelopes" Number lost to follow-up: not stated Length of follow-up: 24 months
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Participants	Orthopaedic unit in Lund, Sweden 199 patients with an intracapsular fracture. 65% of fractures were displaced Mean age: 81 years (range 28 to 101) % male: 24%
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Interventions	Two Hansson hook pins versus three titanium AO cancellous screws
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Outcomes	Length of surgery Poor implant positioning Drill penetration at surgery Non-union and early fracture displacement Avascular necrosis Re-operations - arthroplasty Re-operations - removal Re-operations - Girdlestone excision arthroplasty Length of hospital stay Mortality Walking ability
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Notes	
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Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	"in blocks of 50 with sealed numbered envelopes"

Mjorud 2006 (Continued)

Allocation concealment?	Unclear risk	"in blocks of 50 with sealed numbered envelopes"
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Nordkild 1985

Methods	Method of randomisation: "odd and even numbers" Number lost to follow-up: 0 Length of follow-up: median 40 months (range 1 to 64)
Participants	Orthopaedic unit in Copenhagen, Denmark 49 patients with an intracapsular fracture 78% of fractures were displaced Mean age: 62 years (range 32 to 86) % male: 33%
Interventions	Sliding hip screw versus sliding nail plate The sliding nail plate has a trifin tip and sliding can occur between this and the outer barrel similar to a sliding hip screw. The barrel is attached to a short plate using a locking bolt.
Outcomes	Non-union Avascular necrosis Re-operations Pain Range of movement of the hip Use of walking aids Bone scintigraphy
Notes	A significant difference in mean ages was noted between groups, with those allocated to the nail plate group being younger ($P < 0.025$) The 1987 paper was for 35 of the patients who had bone scintigraphy performed at 6 weeks, 3, 6 and 12 months

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	High risk	"odd and even numbers were used"
Allocation concealment?	High risk	"Odd and even number were used"

Olerud 1991

Methods	Method of randomisation: not stated Number lost to follow-up: 0 Length of follow-up: 12 months
Participants	Orthopaedic unit in Uppsala, Sweden 115 patients with an intracapsular fracture 71% of fractures were displaced Mean age: 80 years (range not stated) % male: 16%
Interventions	Two Hansson pins versus two Uppsala screws Hansson hook pins are 6.5 mm diameter smooth pins with a hook which is extruded at its tip

Internal fixation implants for intracapsular hip fractures in adults (Review)

Olerud 1991 (Continued)

Uppsala screws are 8 mm cancellous screws with a 6 mm shank

Outcomes	Non-union Avascular necrosis Mortality (one year) Pain Mobility Failure to return to same residence
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Notes	Study conducted in the institution where one of the methods of internal fixation was originated
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Risk of bias

Bias	Authors' judgement	Support for judgement
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Adequate sequence generation?	Unclear risk	Not stated
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Allocation concealment?	Unclear risk	Not stated
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Ovesen 1997

Methods	Method of randomisation: not stated Number lost to follow-up: not stated Length of follow-up: mean 24 months
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Participants	Orthopaedic unit in Odense, Denmark 316 fractures in 314 patients with an intracapsular fracture. 80% of fractures were displaced Mean age: not stated (range not stated) % male: not stated
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Interventions	Two Uppsala screws versus sliding hip screw Uppsala screws are 8 mm cancellous screws with a 6 mm shank
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Outcomes	Fracture healing complications Length of surgery Operative blood loss Re-operations - arthroplasty Length of hospital stay Mortality
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Notes	Reported only as a conference abstract
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Risk of bias

Bias	Authors' judgement	Support for judgement
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Adequate sequence generation?	Unclear risk	Not stated
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Allocation concealment?	Unclear risk	Not stated
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Parker 2010

Methods	Method of randomisation: "single toss of a coin" Number lost to follow-up: 2 Length of follow-up: 12 months
Participants	Orthopaedic unit in Peterborough, UK 432 patients with an intracapsular fracture. 44% of fractures were displaced Mean age: 77 years (range 29 to 99) % male: 23%
Interventions	Three 16 mm threaded 6.5 mm cannulated cancellous AO screws versus three 32 mm threaded 6.5 mm cannulated cancellous AO screws
Outcomes	Non-union Avascular necrosis Fracture below the implant Re-operations Pain at follow-up Failure to return to same residence Failure to regain mobility Mortality
Notes	Additional methodological and results provided by Martyn Parker in response to letter from Helen Handoll

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	Randomised by "by the single toss of a coin, heads to 6.5 mm cancellous screws with short threads (16 mm) and tails to long threads (32 mm)"
Allocation concealment?	Unclear risk	Coin toss was done on the ward by surgeon (information from lead investigator)

Paus 1986

Methods	Method of randomisation: "coded envelopes" Number lost to follow-up: 0 Length of follow-up: mean 28 months (range 13 to 41)
Participants	Orthopaedic unit in Aker 131 patients with an intracapsular fracture. 100% of fractures were displaced Mean age: 69 years (all patients aged less than 80 years. Range not stated) % male: 18%
Interventions	Two von Bahr screws versus two sliding hip screws von Bahr screws are 7 mm cancellous screws with a 5.5 mm shank
Outcomes	Non-union Avascular necrosis Re-operations - arthroplasty Re-operations - implant removal Deep wound infection Length of surgery

Paus 1986 (Continued)

Mortality (during follow-up)

Notes Study restricted to patients aged less than 80 years

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	"after the x-ray examinations by selecting a previously coded envelope containing direction of type of operation"
Allocation concealment?	Unclear risk	"after the x-ray examinations by selecting a previously coded envelope containing direction of type of operation"

Rehnberg 1989

 Methods Method of randomisation: "a table of random numbers and they were also matched with respect to age, fracture type and living conditions"
 Number lost to follow-up: 0
 Length of follow-up: 12 months

 Participants Orthopaedic unit in Uppsala, Sweden
 222 patients with an intracapsular fracture.
 77% of fractures were displaced
 Mean age: 80 years (range 55 to 98)
 % male: 25%

 Interventions Two von Bahr screws versus two Uppsala screws
 von Bahr screws are 7 mm cancellous screws with a 5.5 mm shank
 Uppsala screws are 8 mm cancellous screws with a 6 mm shank

 Outcomes Non-union
 Avascular necrosis
 Screw penetration
 Re-operations - arthroplasty
 Re-operations - implant removal
 Length of surgery
 Operative blood loss
 Mortality (one year)
 Pain
 Use of walking aids
 Failure to return to same residence

Notes Study conducted in the institution where one of the methods of internal fixation was originated

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	"a table of random numbers and they were also matched with respect to age, fracture type and living conditions"
Allocation concealment?	Unclear risk	"a table of random numbers and they were also matched with respect to age, fracture type and living conditions"

Sernbo 1990

Methods	Method of randomisation: "in the operating theatre by a random number generator" Number lost to follow-up: 1 (0.2%) Length of follow-up: mean 24 months
Participants	Orthopaedic unit in Malmo, Sweden 410 patients with an intracapsular fracture. 75% of fractures were displaced Mean age: 77 years (range not stated) % male: 25%
Interventions	Rydell four flanged nail versus two Hansson hook pins (LIH pins) Rydell nail is a four flanged nail with a hook extruded at its tip Hansson hook pins are 6.5 mm diameter smooth pins with a hook which is extruded at its tip
Outcomes	Length of surgery Radiographic screening time Operative blood loss Non-union Avascular necrosis Re-operations - arthroplasty Re-operations - implant removal Length of hospital stay Failure to return home
Notes	Figures for number of complications and re-operations were inferred from table of figures which gave percentages

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	"in the operating theatre by a random number generator"
Allocation concealment?	Unclear risk	"in the operating theatre by a random number generator"

Sorensen 1992

Methods	Method of randomisation: not stated Number lost to follow-up: 1 (1.4%) Length of follow-up: mean 36 months
Participants	Orthopaedic unit in Hellerup, Denmark 73 patients with an intracapsular fracture. 86% of fractures were displaced Mean age: 77 years (range 52 to 94) % male: 25%
Interventions	Sliding hip screw versus three Gouffon screws Gouffon pins are 6.5 mm cancellous screws
Outcomes	Non-union Avascular necrosis Re-operations - arthroplasty Re-operations - implant removal

Sorensen 1992 (Continued)

Mortality (three years)

Notes Trial was discontinued early due to higher failure rate in the Gouffon screw group

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Sorensen 1996

 Methods Method of randomisation: not stated
 Number lost to follow-up: 14 (9.3%)
 Length of follow-up: mean 12 months

 Participants Orthopaedic unit in Gentofte, Denmark
 150 patients with an intracapsular fracture.
 67% of fractures were displaced
 Mean age: 80 years (range 47 to 94)
 % male: 25%

 Interventions Sliding hip screw versus two Hansson hook pins (LIH pins) versus two Uppsala screws
 Hansson hook pins are 6.5 mm diameter smooth pins with a hook which is extruded at its tip
 Uppsala screws are 8 mm cancellous screws with a 6 mm shank

Outcomes Total radiographic complications (penetration, early loosening, non-union, avascular necrosis)

Notes Reported as a conference abstract only

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated
Allocation concealment?	Unclear risk	Not stated

Stromquist 1988

 Methods Method of randomisation: even or odd date of birth
 Number lost to follow-up: 3 (3.6%)
 Length of follow-up: 4 months

 Participants Orthopaedic unit in Helsingborg, Sweden
 110 patients with an intracapsular fracture.
 64% of fractures were displaced
 Mean age: 77 years (range 32 to 92)
 % male: 25%

Stromquist 1988 (Continued)

Interventions	Two AO screws versus two Hansson hook pins AO screws are have 6.5 mm cancellous threads Hansson hook pins (LIH) are 6.5 mm diameter smooth pins with a hook which is extruded at its tip
Outcomes	Re-operation Need for re-operation - arthroplasty Mortality (4 months) Bone scintimetry
Notes	Study translated from article in French courtesy of Celine Froidevaux

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	High risk	Even or odd date of birth
Allocation concealment?	High risk	Even or odd date of birth

Stromqvist 1984

Methods	Method of randomisation: even or odd date of birth Number lost to follow-up: 0 Length of follow-up: 24 months
Participants	Orthopaedic unit in Lund, Sweden 152 patients with an intracapsular fracture. 72% of fractures were displaced Mean age: 78 years (range 52 to 95) % male: not stated
Interventions	Rydell four flanged nail versus two Hansson hook pins (LIH pins) Rydell nail is a four flanged nail with a hook extruded at its tip Hansson hook pins are 6.5 mm diameter smooth pins with a hook which is extruded at its tip
Outcomes	Non-union Avascular necrosis Re-operations Deep wound infection Mortality at two years Bone scintimetry
Notes	Lars Hansson, one of the paper's co-authors, was the inventor of the Hansson pin The 1983 paper related to the results of post-operative bone scintimetric evaluation for 134 of the patients

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	High risk	"AO screws were inserted if they were born on an even day, and with hook pins if they were born on an odd day"

Stromqvist 1984 (Continued)

Allocation concealment?	High risk	“AO screws were inserted if they were born on an even day, and with hook pins if they were born on an odd day”
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Svenningsen 1984

Methods	Method of randomisation: not stated Number lost to follow-up: 7 (2.7%) Length of follow-up: mean 36 months
Participants	Orthopaedic unit in Trondheim, Norway 255 patients with an intracapsular fracture. 69% of fractures were displaced Mean age: 71 years (range not stated) % male: 25%
Interventions	Sliding compression screw plate versus McLaughlin nail plate The compression screw plate was similar to a short one hole plate sliding hip screw with an additional screw proximally and a compression device incorporated into the plate barrel The nail plate used was a Thornton trifin nail connected to a side plate by a locking bolt
Outcomes	Non-union Avascular necrosis Re-operations - implant removal Superficial wound infection Deep wound infection Length of surgery Fall in haemoglobin Mortality Length of hospital stay
Notes	The trial also has a prosthesis group. Results for this part of the study are included within the Cochrane review of internal fixation versus arthroplasty for intracapsular fractures. Subgroup of patients aged over 70 years reported in addition in the paper of Svenningsen 1985

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	not stated
Allocation concealment?	Unclear risk	not stated

Wihlborg 1990

Methods	Method of randomisation: "sealed envelopes" Number lost to follow-up: 0 Length of follow-up: 24 months
Participants	Orthopaedic unit in Ljungby, Sweden 200 patients with an intracapsular fracture. 83% of fractures were displaced

Wihlborg 1990 (Continued)

Mean age: 77 years (range 46 to 100)
 % male: 29%

Interventions	Three Gouffon pins versus Rydell four flanged nail Gouffon pins are 6.5 mm cancellous screws The Rydell nail is a four flanged nail with a hook extruded at its tip
Outcomes	Non-union Avascular necrosis Re-operations Mortality (one and two years)
Notes	Once randomised, patients were allocated to a surgeon who was familiar with the implant to which the patient had been allocated to receive

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	"randomized cards indicating the group of surgeons to which the patient was to be allocated were kept in sealed envelopes that were opened on the day of the operation"
Allocation concealment?	Unclear risk	"randomized cards indicating the group of surgeons to which the patient was to be allocated were kept in sealed envelopes that were opened on the day of the operation"

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Ingwersen 1992	This prospective randomised trial was reported only as a conference abstract. The study compared 100 patients treated with either two Olmed screws or two Richards screws. Twenty-six patients were subsequently excluded for the operation being the wrong indication (9), died (12) or lost to follow-up (5). Follow-up was for only three months (range two to six months). No loss of fixation was reported in the undisplaced fractures. For the displaced fracture 're-dislocation' was reported in 14/29 of the Olmed screws and 23/31 of the Richard screws. The study was excluded as there was only a limited follow-up and inadequate reporting of results.
Jukkala-Partio 2000	This was a comparative study of 40 patients in which their intracapsular fracture was fixed with metallic screws and 40 patients who had their fracture fixed with three bioabsorbable screws. For undisplaced fracture non-union occurred in 5/29 and 8/29 for the bioabsorbable screws versus the metal screws. For displaced fractures non-union occurred in 6/11 cases for both groups. Walking ability and range of movement were reported to be better after the bioabsorbable fixation. The study was excluded as there was no randomisation of patients.
Poulsen 1995	This is a retrospective review of 182 patients treated at one centre where one department treated the patients by sliding screw plate and the other department used the sliding hip screw. It was excluded, as it was not a randomised controlled trial.
Sernbo 1986	This randomised trial reported only as a conference abstract involved 300 patients with an intracapsular fracture randomised to either the Rydell nail or three cannulated screws. After one and two years there was 'no significant difference' in the mortality, walking capacity or social rehabilitation between the two groups. Complications of displacement, avascular necrosis and

Study	Reason for exclusion
	pseudarthrosis occurred in 36% of the Rydell group and 30% of the cannulated screw group, with re-operations in 20% of the Rydell group and 16% of the screw group. The study was excluded as because there was inadequate reporting of results within the conference abstract and no mention of the number of patients in each group.

Characteristics of ongoing studies [ordered by study ID]

FAITH

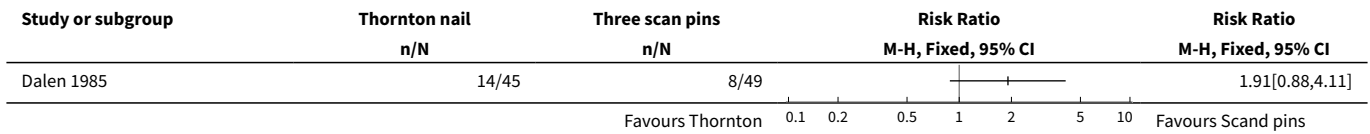
Trial name or title	Fixation using Alternative Implants for the Treatment of Hip fractures (FAITH): a multi-centre randomised trial comparing sliding hip screws and cancellous screws on revision surgery rates and quality of life in the treatment of femoral neck fractures
Methods	A multi-centre randomised trial
Participants	Patients with an intracapsular fracture that is to be treated by internal fixation
Interventions	Comparing sliding hip screws and cancellous screws
Outcomes	Primary outcome measures: Revision surgery Secondary outcome measures: Function, quality of life, complications, including mortality, avascular necrosis, nonunion, implant breakage or failure, implant removal after fracture healing to minimize pain, and infection.
Starting date	March 2009
Contact information	Julie Agel, MA 612-273-8052 (agelx001@umn.edu)
Notes	Predicted end date March 2013

DATA AND ANALYSES

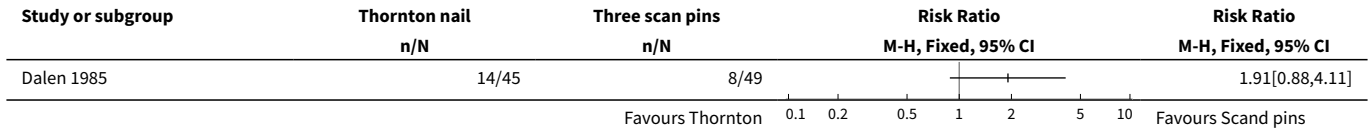
Comparison 1. Thornton nail versus three Scand pins

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Re-operations	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Analysis 1.1. Comparison 1 Thornton nail versus three Scand pins, Outcome 1 All fracture healing complications.



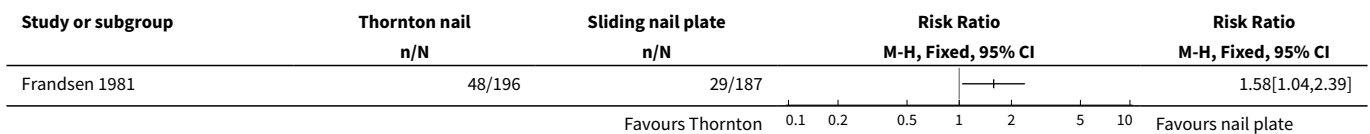
Analysis 1.2. Comparison 1 Thornton nail versus three Scand pins, Outcome 2 Re-operations.



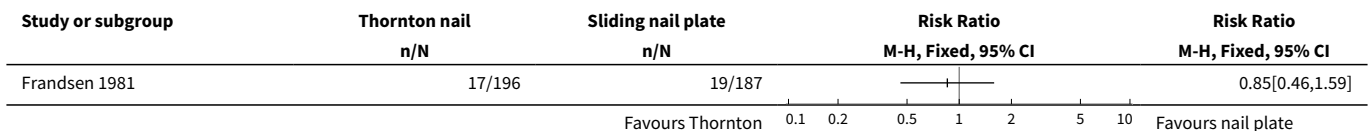
Comparison 2. Thornton nail versus sliding nail plate

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

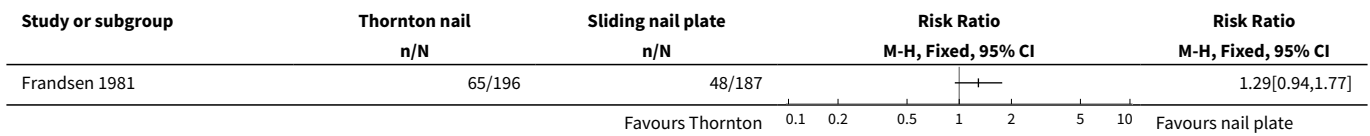
Analysis 2.1. Comparison 2 Thornton nail versus sliding nail plate, Outcome 1 Non-union.



Analysis 2.2. Comparison 2 Thornton nail versus sliding nail plate, Outcome 2 Avascular necrosis.



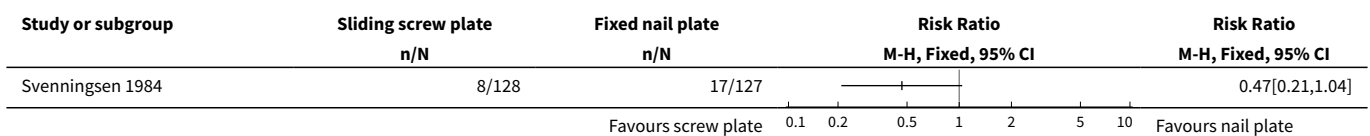
Analysis 2.3. Comparison 2 Thornton nail versus sliding nail plate, Outcome 3 All fracture healing complications.



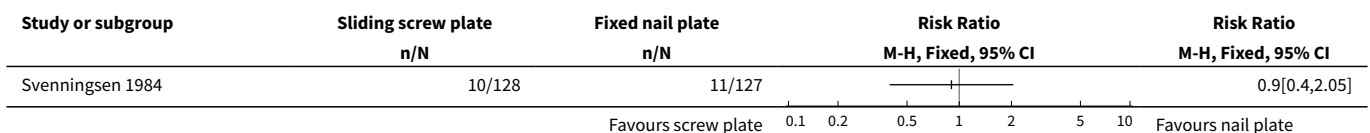
Comparison 3. Sliding compression screw plate versus fixed nail plate

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Re-operations - implant removal	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Superficial wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6 Deep wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7 Mortality - 1 year	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

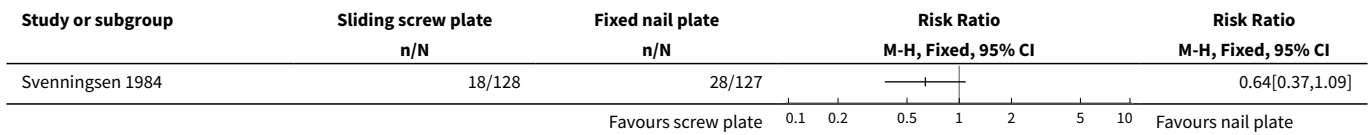
Analysis 3.1. Comparison 3 Sliding compression screw plate versus fixed nail plate, Outcome 1 Non-union.



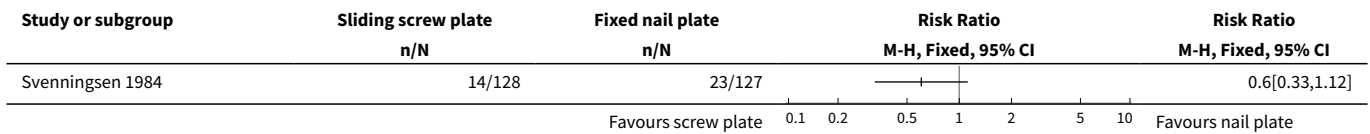
Analysis 3.2. Comparison 3 Sliding compression screw plate versus fixed nail plate, Outcome 2 Avascular necrosis.



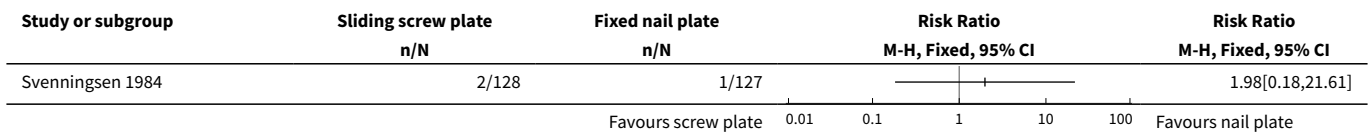
Analysis 3.3. Comparison 3 Sliding compression screw plate versus fixed nail plate, Outcome 3 All fracture healing complications.



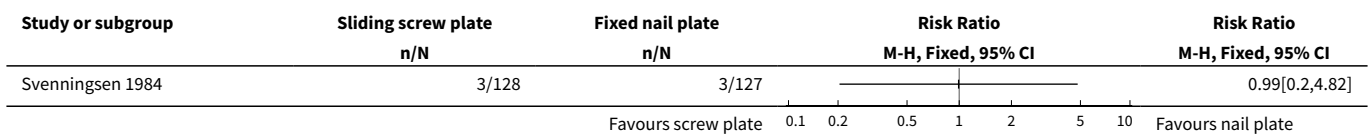
Analysis 3.4. Comparison 3 Sliding compression screw plate versus fixed nail plate, Outcome 4 Re-operations - implant removal.



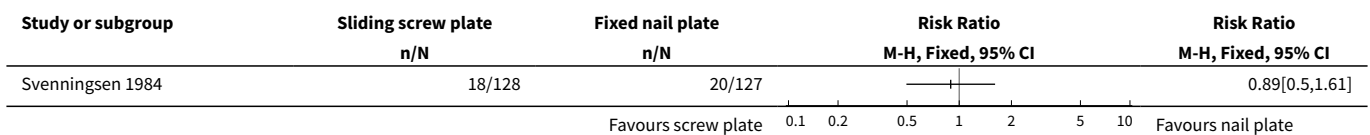
Analysis 3.5. Comparison 3 Sliding compression screw plate versus fixed nail plate, Outcome 5 Superficial wound infection.



Analysis 3.6. Comparison 3 Sliding compression screw plate versus fixed nail plate, Outcome 6 Deep wound infection.



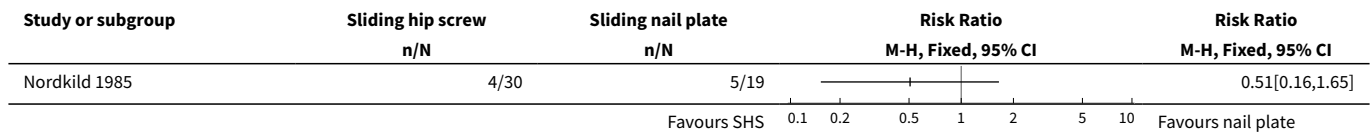
Analysis 3.7. Comparison 3 Sliding compression screw plate versus fixed nail plate, Outcome 7 Mortality - 1 year.



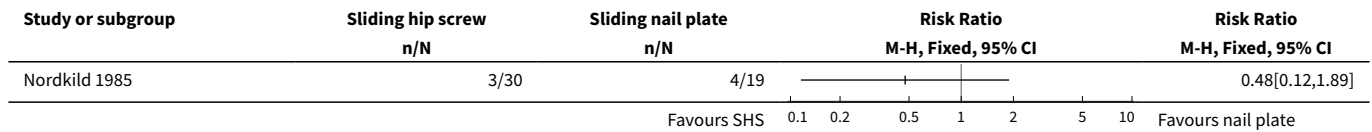
Comparison 4. Sliding hip screw versus sliding nail plate

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 Re-operations - arthroplasty	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Pain at follow-up	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

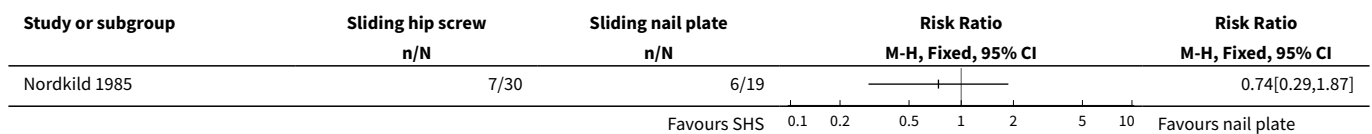
Analysis 4.1. Comparison 4 Sliding hip screw versus sliding nail plate, Outcome 1 Non-union.



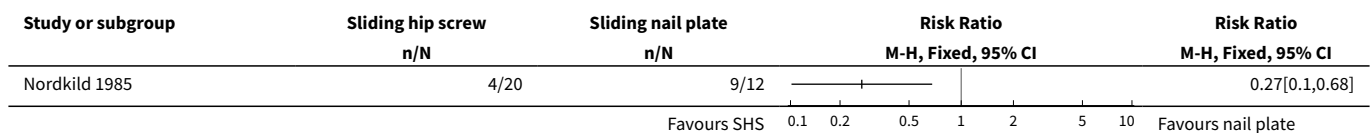
Analysis 4.2. Comparison 4 Sliding hip screw versus sliding nail plate, Outcome 2 Avascular necrosis.



Analysis 4.3. Comparison 4 Sliding hip screw versus sliding nail plate, Outcome 3 Re-operations - arthroplasty.



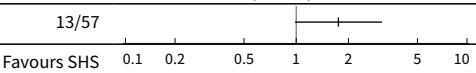
Analysis 4.4. Comparison 4 Sliding hip screw versus sliding nail plate, Outcome 4 Pain at follow-up.



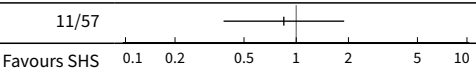
Comparison 5. Sliding hip screw versus double divergent pins

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Re-operations	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Use of walking aids at follow-up	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

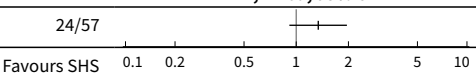
Analysis 5.1. Comparison 5 Sliding hip screw versus double divergent pins, Outcome 1 Non-union.

Study or subgroup	Sliding hip screw n/N	Double divergent pin n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
Christie 1988	22/55	13/57		1.75[0.98,3.12]

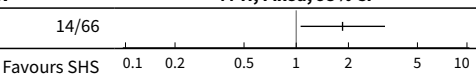
Analysis 5.2. Comparison 5 Sliding hip screw versus double divergent pins, Outcome 2 Avascular necrosis.

Study or subgroup	Sliding hip screw n/N	Double divergent pin n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
Christie 1988	9/55	11/57		0.85[0.38,1.89]

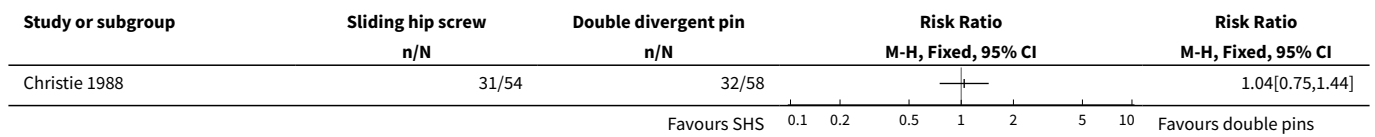
Analysis 5.3. Comparison 5 Sliding hip screw versus double divergent pins, Outcome 3 All fracture healing complications.

Study or subgroup	Sliding hip screw n/N	Double divergent pin n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
Christie 1988	31/55	24/57		1.34[0.91,1.96]

Analysis 5.4. Comparison 5 Sliding hip screw versus double divergent pins, Outcome 4 Re-operations.

Study or subgroup	Sliding hip screw n/N	Double divergent pin n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
Christie 1988	24/61	14/66		1.85[1.06,3.25]

Analysis 5.5. Comparison 5 Sliding hip screw versus double divergent pins, Outcome 5 Use of walking aids at follow-up.



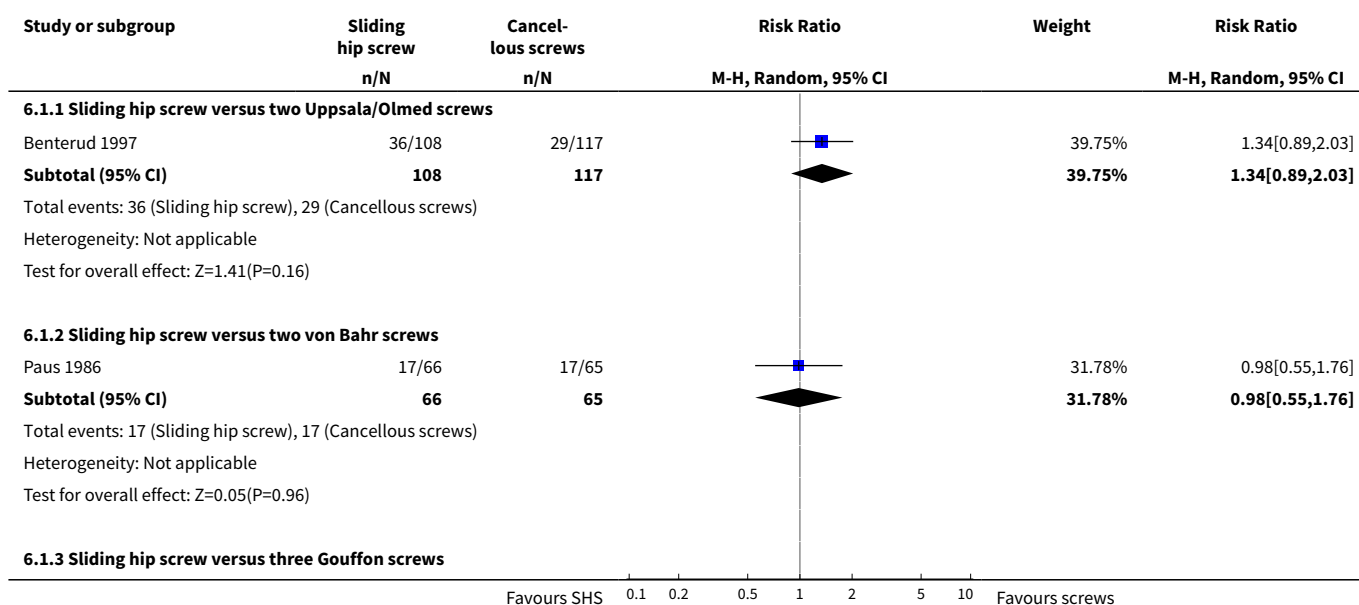
Comparison 6. Sliding hip screw versus cancellous screws

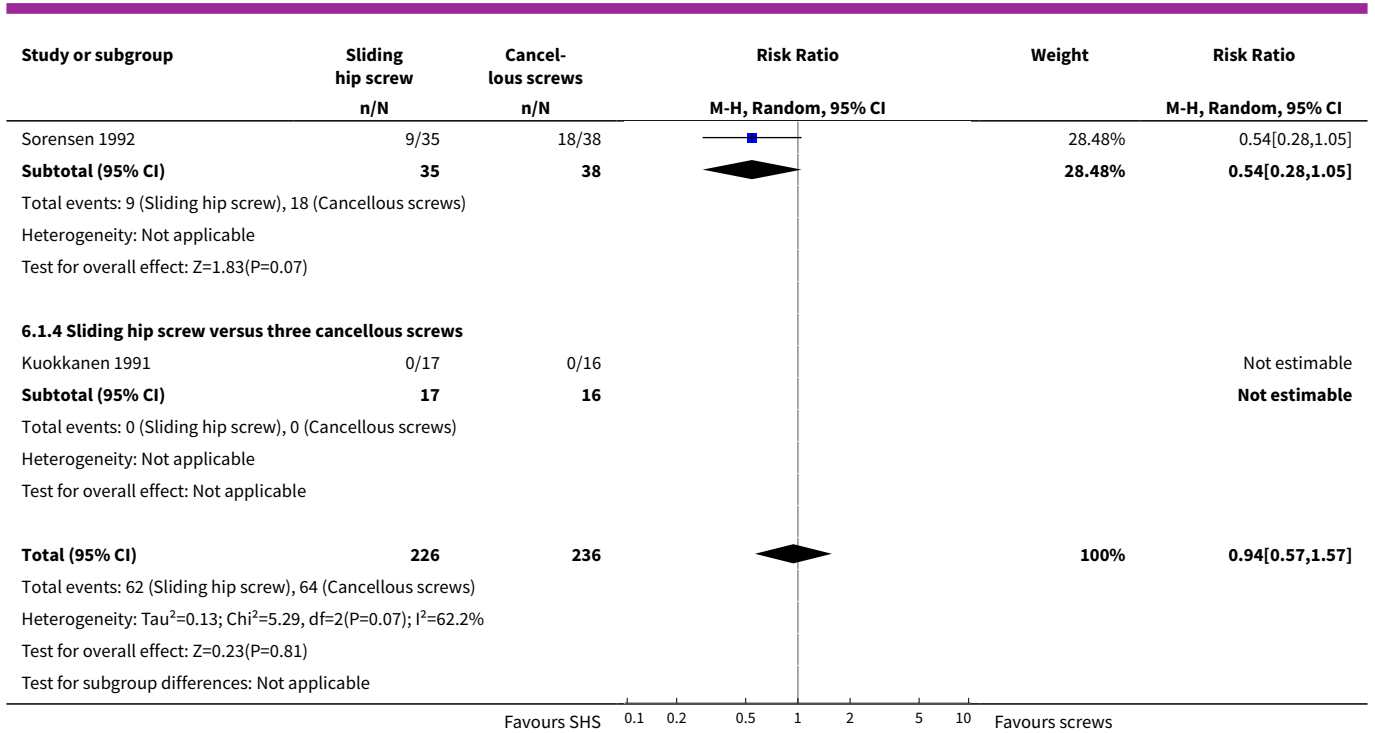
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	4	462	Risk Ratio (M-H, Random, 95% CI)	0.94 [0.57, 1.57]
1.1 Sliding hip screw versus two Uppsala/Olmed screws	1	225	Risk Ratio (M-H, Random, 95% CI)	1.34 [0.89, 2.03]
1.2 Sliding hip screw versus two von Bahr screws	1	131	Risk Ratio (M-H, Random, 95% CI)	0.98 [0.55, 1.76]
1.3 Sliding hip screw versus three Gouffon screws	1	73	Risk Ratio (M-H, Random, 95% CI)	0.54 [0.28, 1.05]
1.4 Sliding hip screw versus three cancellous screws	1	33	Risk Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
2 Avascular necrosis	5	565	Risk Ratio (M-H, Fixed, 95% CI)	0.62 [0.38, 1.01]
2.1 Sliding hip screw versus two Uppsala/Olmed screws	1	225	Risk Ratio (M-H, Fixed, 95% CI)	0.79 [0.38, 1.65]
2.2 Sliding hip screw versus two von Bahr screws	1	131	Risk Ratio (M-H, Fixed, 95% CI)	0.59 [0.23, 1.53]
2.3 Sliding hip screw versus three Gouffon screws	1	73	Risk Ratio (M-H, Fixed, 95% CI)	0.47 [0.13, 1.66]
2.4 Sliding hip screw versus three cancellous screws	1	33	Risk Ratio (M-H, Fixed, 95% CI)	0.19 [0.01, 3.66]
2.5 Sliding hip screw versus four cancellous screws	1	103	Risk Ratio (M-H, Fixed, 95% CI)	0.61 [0.15, 2.43]
3 All fracture healing complications	6	772	Risk Ratio (M-H, Fixed, 95% CI)	0.86 [0.70, 1.05]
3.1 Sliding hip screw versus two Uppsala/Olmed screws	2	326	Risk Ratio (M-H, Fixed, 95% CI)	1.07 [0.81, 1.40]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.2 Sliding hip screw versus two von Bahr screws	1	131	Risk Ratio (M-H, Fixed, 95% CI)	0.84 [0.54, 1.30]
3.3 Sliding hip screw versus three Gouffon screws	1	73	Risk Ratio (M-H, Fixed, 95% CI)	0.52 [0.31, 0.87]
3.4 Sliding hip screw versus three cancellous screws	2	242	Risk Ratio (M-H, Fixed, 95% CI)	0.60 [0.28, 1.27]
4 Re-operations - arthroplasty	5	565	Risk Ratio (M-H, Fixed, 95% CI)	0.99 [0.74, 1.33]
4.1 Sliding hip screw versus two Uppsala/Olmed screws	1	225	Risk Ratio (M-H, Fixed, 95% CI)	1.15 [0.76, 1.75]
4.2 Sliding hip screw versus two von Bahr screws	1	131	Risk Ratio (M-H, Fixed, 95% CI)	0.98 [0.53, 1.85]
4.3 Sliding hip screw versus three Gouffon screws	1	73	Risk Ratio (M-H, Fixed, 95% CI)	0.60 [0.32, 1.12]
4.4 Sliding hip screw versus three cancellous screws	1	33	Risk Ratio (M-H, Fixed, 95% CI)	0.19 [0.01, 3.66]
4.5 Sliding hip screw versus four cancellous screws	1	103	Risk Ratio (M-H, Fixed, 95% CI)	2.38 [0.65, 8.70]
5 Re-operations - implant removal	5	565	Risk Ratio (M-H, Random, 95% CI)	0.86 [0.30, 2.45]
5.1 Sliding hip screw versus two Uppsala/Olmed screws	1	225	Risk Ratio (M-H, Random, 95% CI)	2.17 [0.56, 8.45]
5.2 Sliding hip screw versus two von Bahr screws	1	131	Risk Ratio (M-H, Random, 95% CI)	0.20 [0.04, 0.86]
5.3 Sliding hip screw versus three Gouffon screws	1	73	Risk Ratio (M-H, Random, 95% CI)	0.54 [0.05, 5.73]
5.4 Sliding hip screw versus three cancellous screws	1	33	Risk Ratio (M-H, Random, 95% CI)	3.29 [0.80, 13.57]
5.5 Sliding hip screw versus four cancellous screws	1	103	Risk Ratio (M-H, Random, 95% CI)	0.51 [0.16, 1.59]
6 Deep wound infection	4	492	Risk Ratio (M-H, Fixed, 95% CI)	2.66 [0.63, 11.25]
6.1 Sliding hip screw versus two Uppsala/Olmed screws	1	225	Risk Ratio (M-H, Fixed, 95% CI)	5.41 [0.26, 111.49]
6.2 Sliding hip screw versus two von Bahr screws	1	131	Risk Ratio (M-H, Fixed, 95% CI)	1.97 [0.18, 21.20]

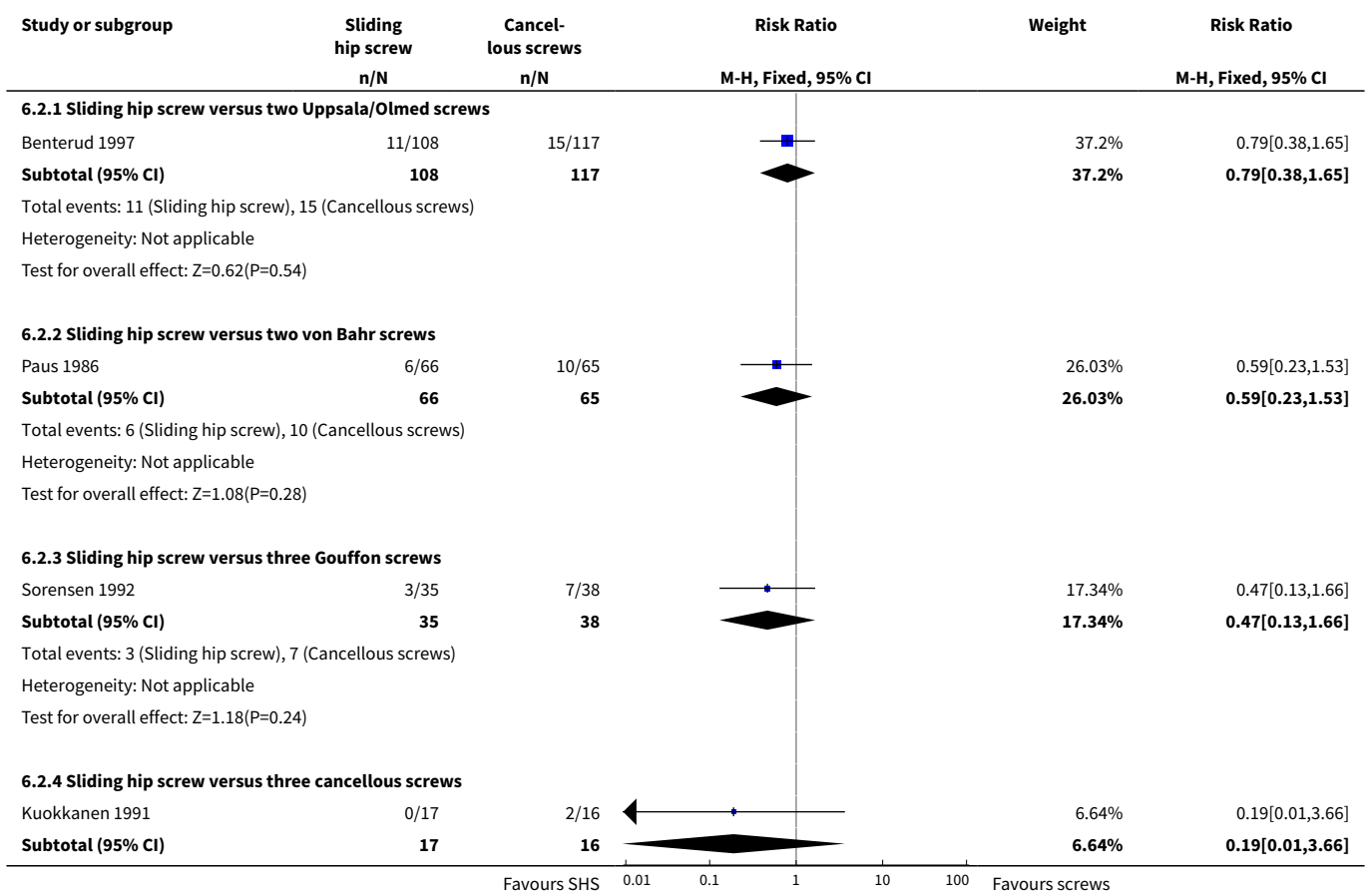
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6.3 Sliding hip screw versus three cancellous screws	1	33	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
6.4 Sliding hip screw versus four cancellous screws	1	103	Risk Ratio (M-H, Fixed, 95% CI)	2.04 [0.19, 21.80]
7 Mortality	5	671	Risk Ratio (M-H, Fixed, 95% CI)	1.25 [0.83, 1.89]
7.1 Sliding hip screw versus two Uppsala/Olmed screws	1	225	Risk Ratio (M-H, Fixed, 95% CI)	1.08 [0.49, 2.40]
7.2 Sliding hip screw versus two von Bahr screws	1	131	Risk Ratio (M-H, Fixed, 95% CI)	0.55 [0.19, 1.55]
7.3 Sliding hip screw versus three Gouffon screws	1	73	Risk Ratio (M-H, Fixed, 95% CI)	2.53 [1.09, 5.86]
7.4 Sliding hip screw versus three cancellous screws	2	242	Risk Ratio (M-H, Fixed, 95% CI)	1.34 [0.61, 2.95]
8 Pain at follow-up	2	298	Risk Ratio (M-H, Fixed, 95% CI)	0.81 [0.58, 1.12]
8.1 Sliding hip screw versus two Uppsala/Olmed screws	1	225	Risk Ratio (M-H, Fixed, 95% CI)	0.94 [0.55, 1.62]
8.2 Sliding hip screw versus three Gouffon screws	1	73	Risk Ratio (M-H, Fixed, 95% CI)	0.70 [0.48, 1.01]

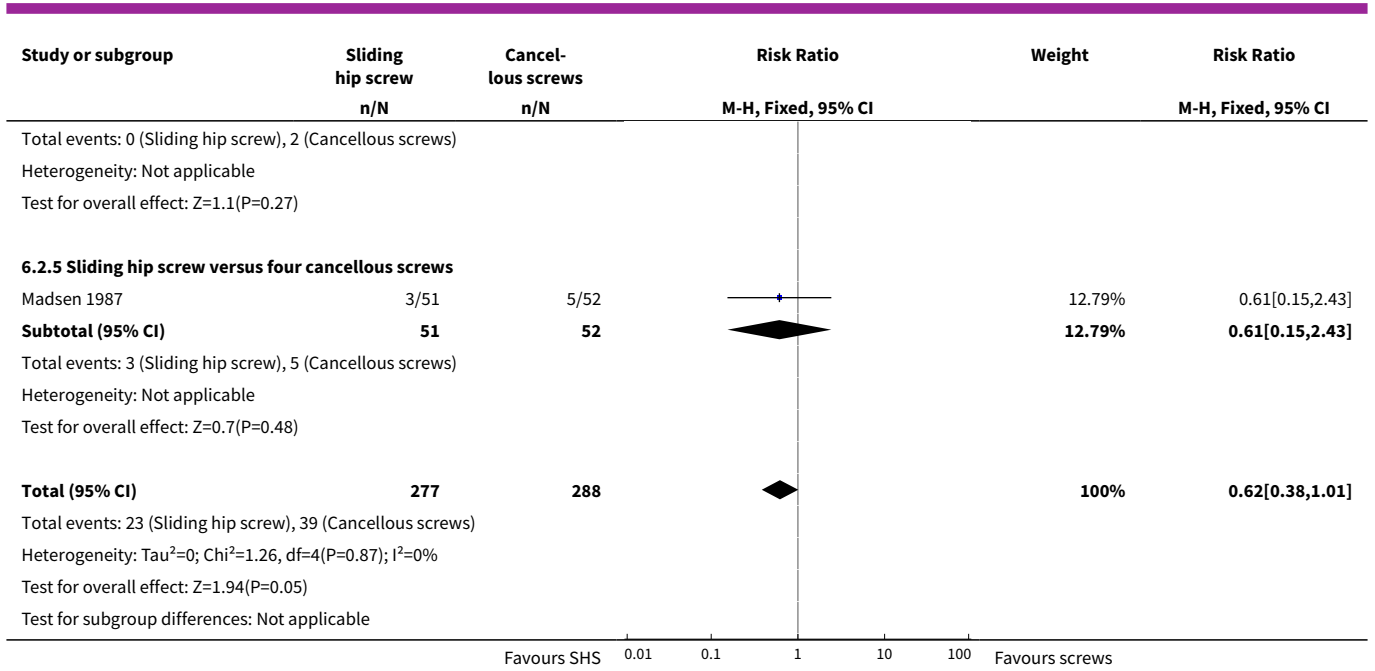
Analysis 6.1. Comparison 6 Sliding hip screw versus cancellous screws, Outcome 1 Non-union.



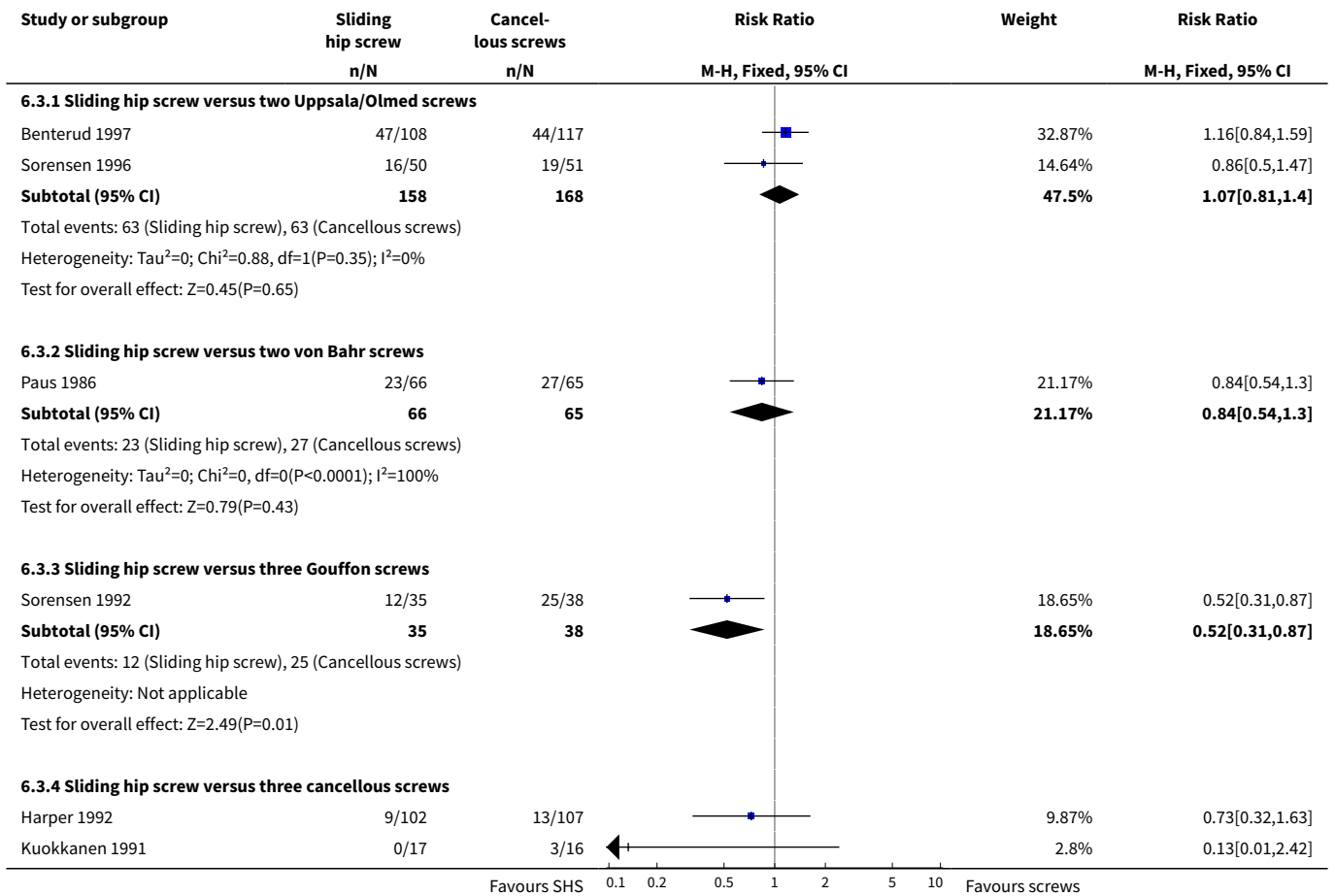


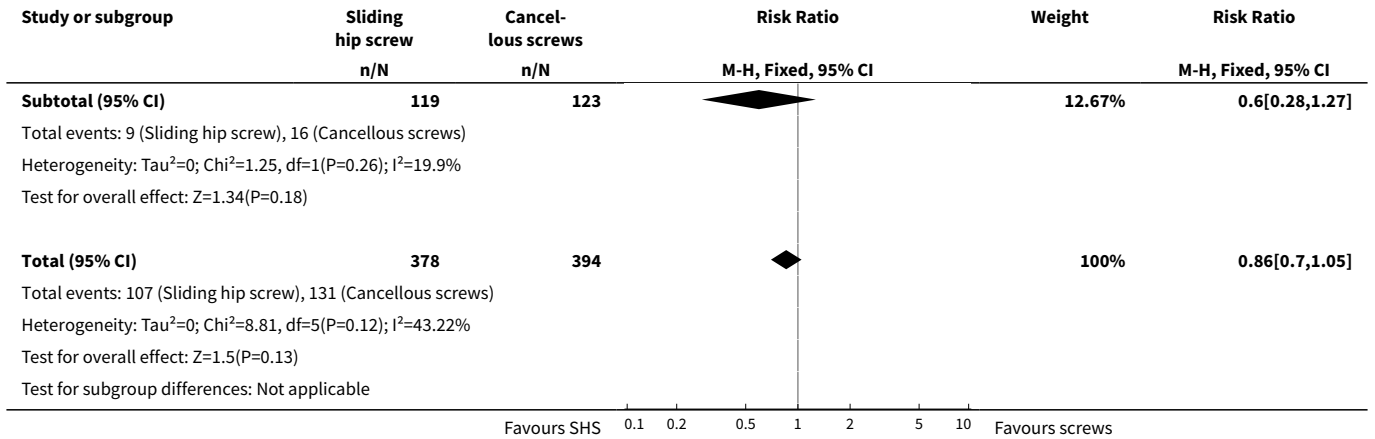
Analysis 6.2. Comparison 6 Sliding hip screw versus cancellous screws, Outcome 2 Avascular necrosis.



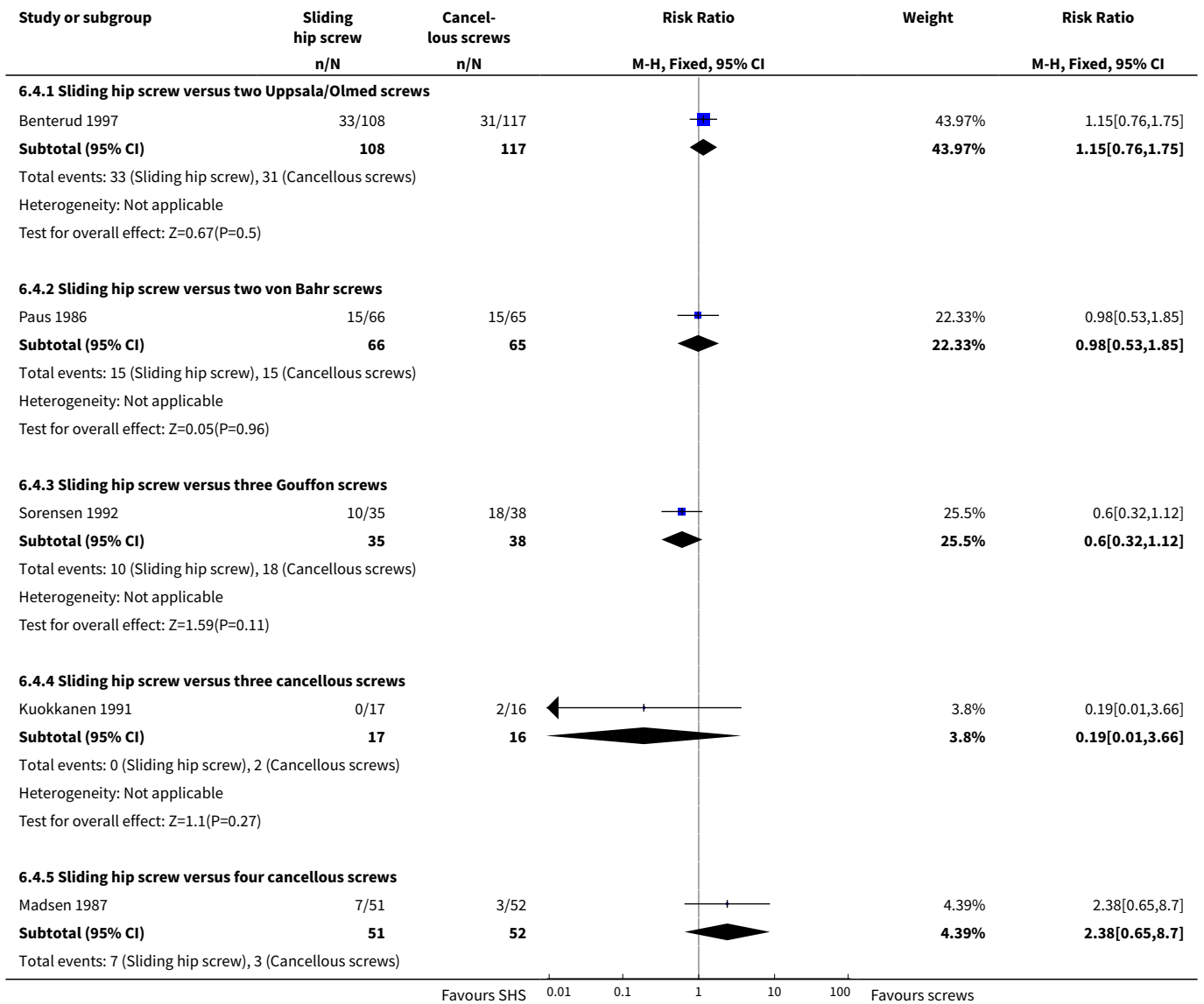


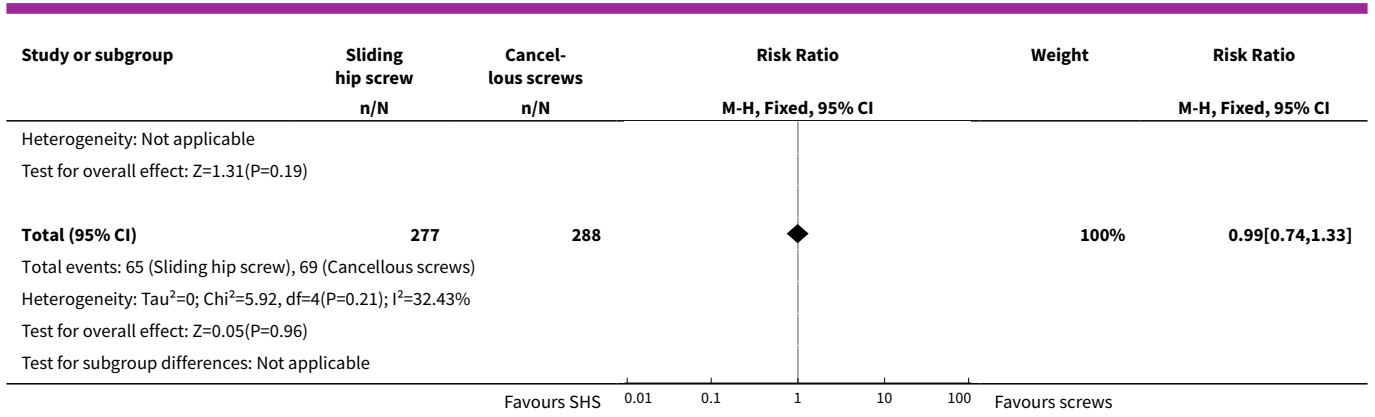
Analysis 6.3. Comparison 6 Sliding hip screw versus cancellous screws, Outcome 3 All fracture healing complications.



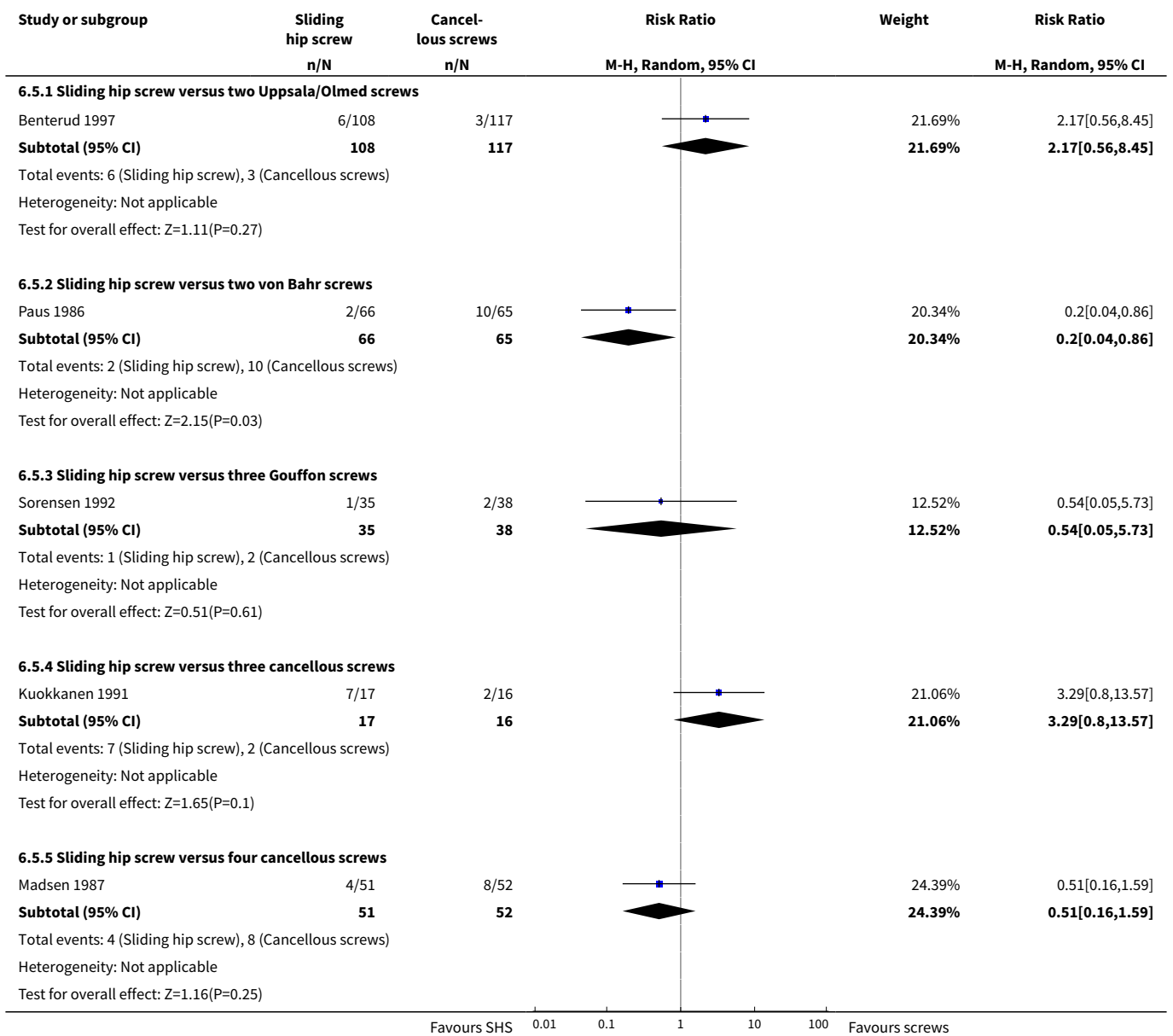


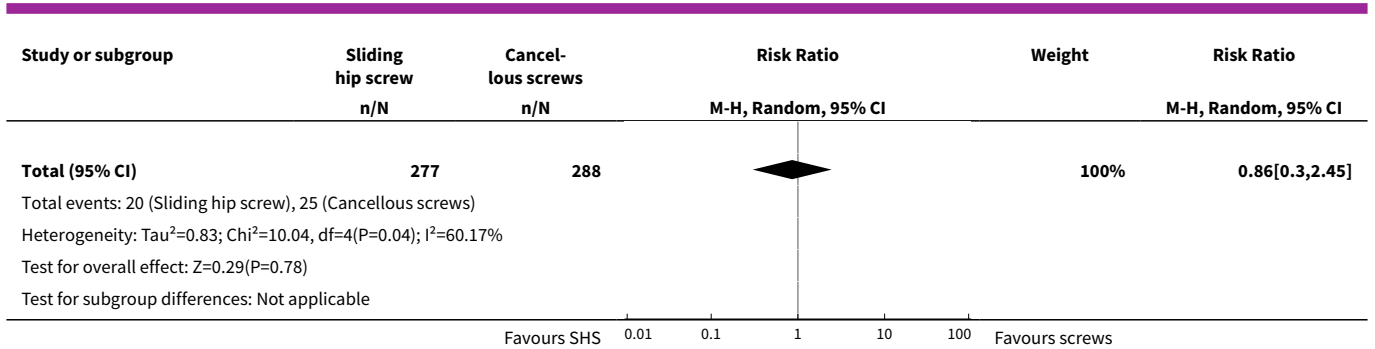
Analysis 6.4. Comparison 6 Sliding hip screw versus cancellous screws, Outcome 4 Re-operations - arthroplasty.



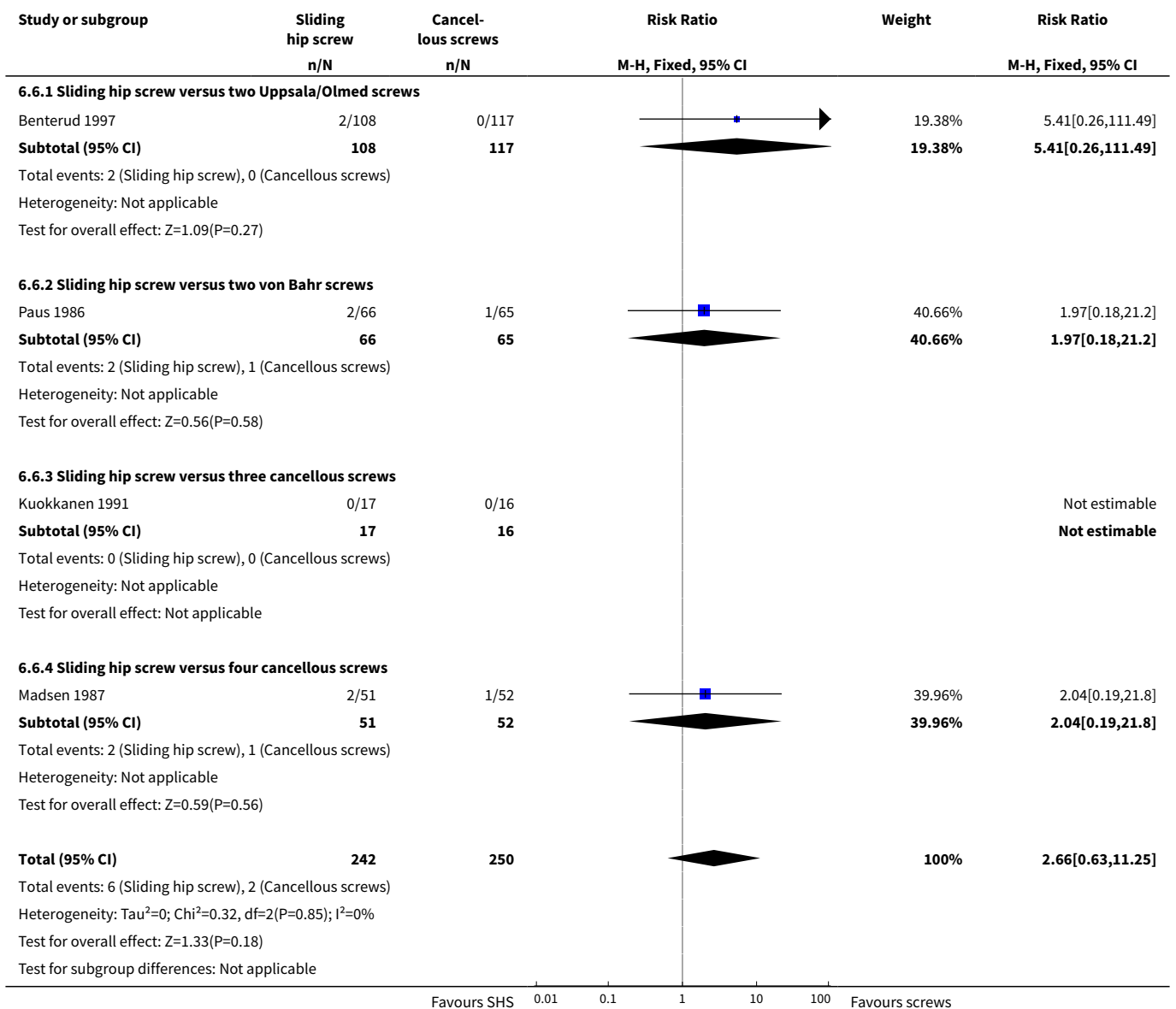


Analysis 6.5. Comparison 6 Sliding hip screw versus cancellous screws, Outcome 5 Re-operations - implant removal.

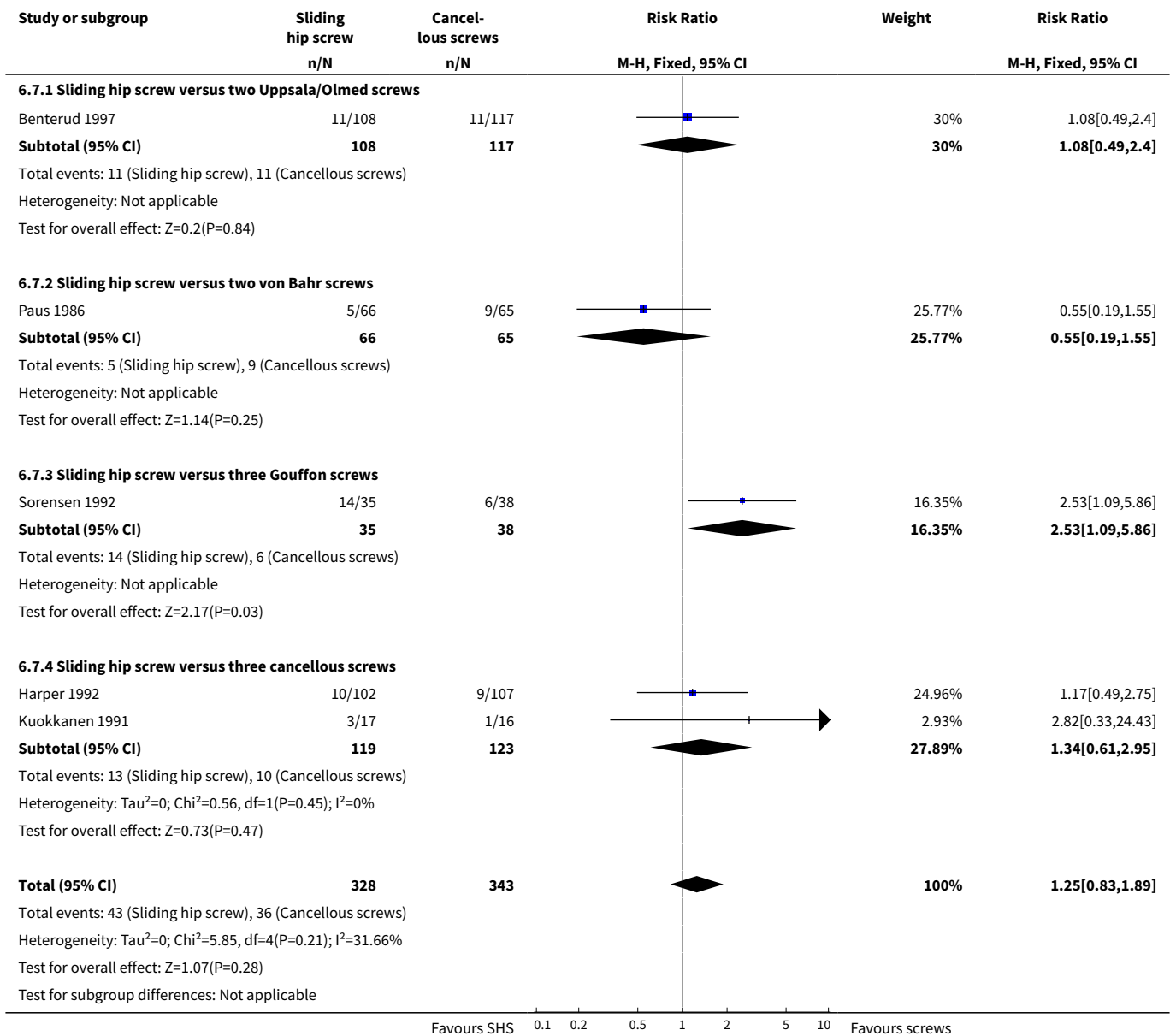




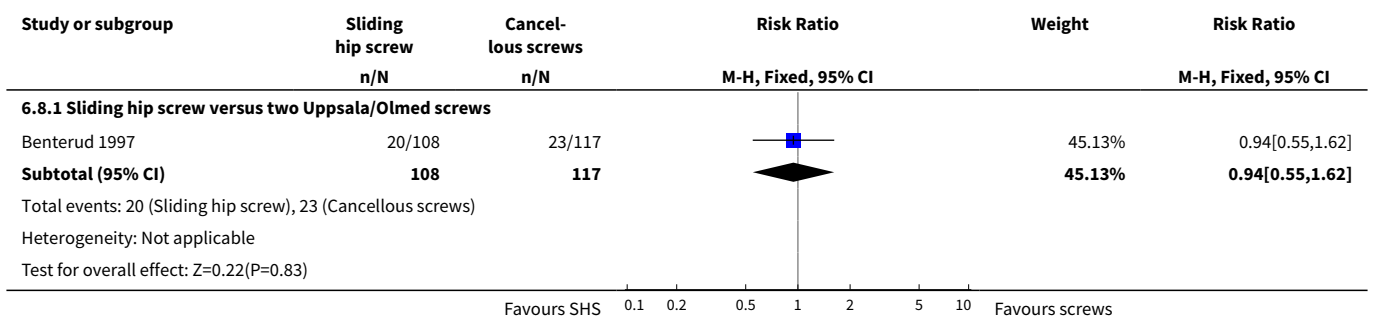
Analysis 6.6. Comparison 6 Sliding hip screw versus cancellous screws, Outcome 6 Deep wound infection.

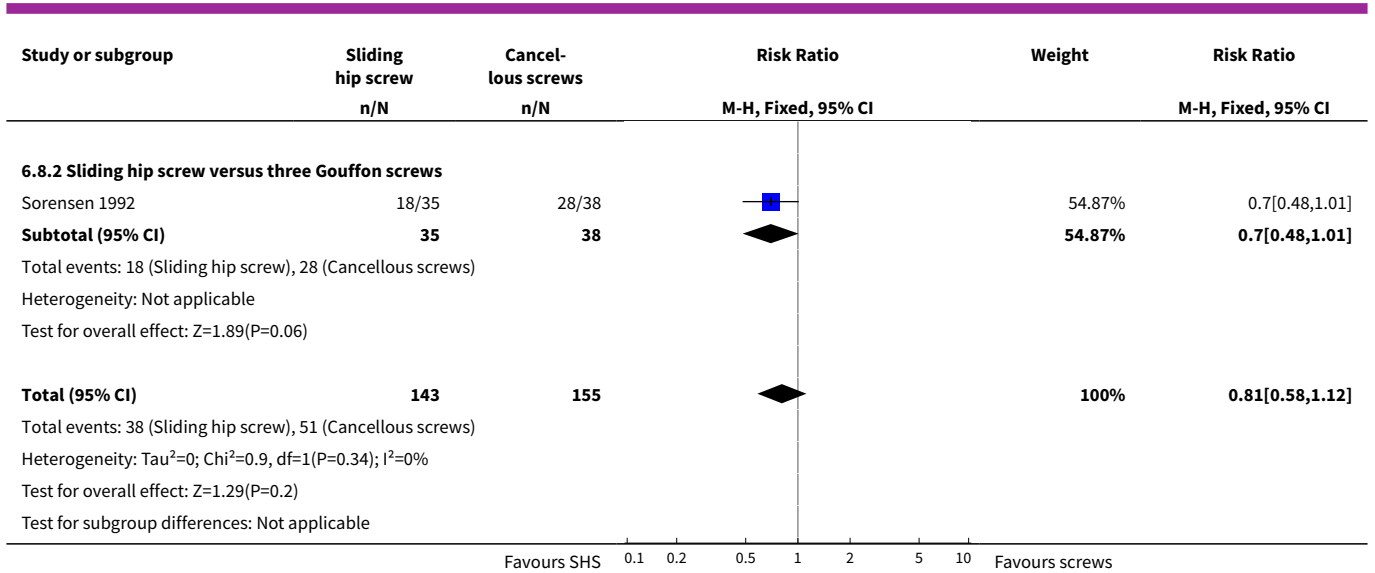


Analysis 6.7. Comparison 6 Sliding hip screw versus cancellous screws, Outcome 7 Mortality.



Analysis 6.8. Comparison 6 Sliding hip screw versus cancellous screws, Outcome 8 Pain at follow-up.

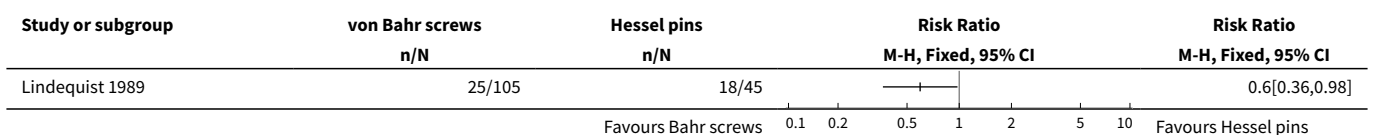




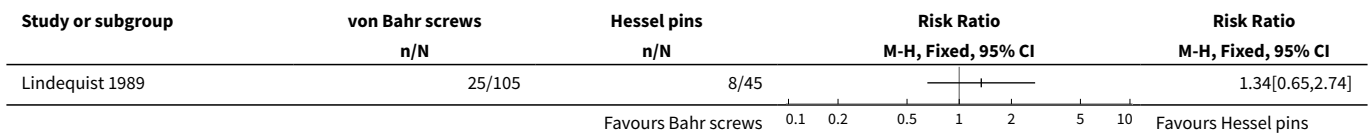
Comparison 7. von Bahr screws versus Hessel pins

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Re-operations - arthroplasty	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Re-operations - implant removal	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6 Superficial wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7 Deep wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
8 Mortality - 2 years	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

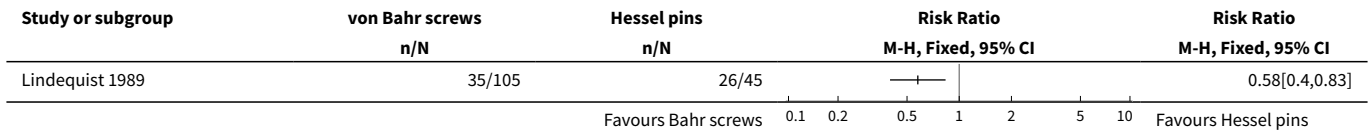
Analysis 7.1. Comparison 7 von Bahr screws versus Hessel pins, Outcome 1 Non-union.



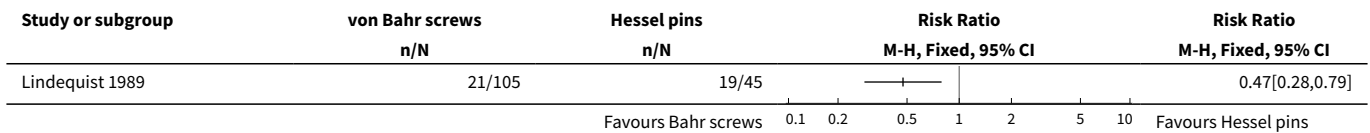
Analysis 7.2. Comparison 7 von Bahr screws versus Hessel pins, Outcome 2 Avascular necrosis.



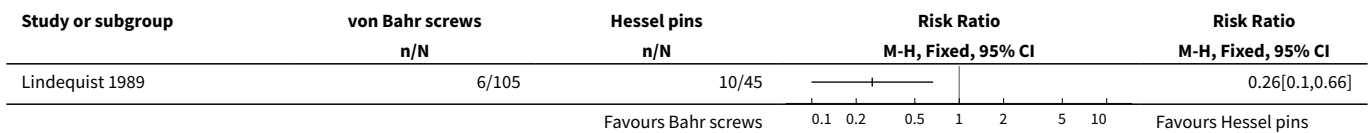
Analysis 7.3. Comparison 7 von Bahr screws versus Hessel pins, Outcome 3 All fracture healing complications.



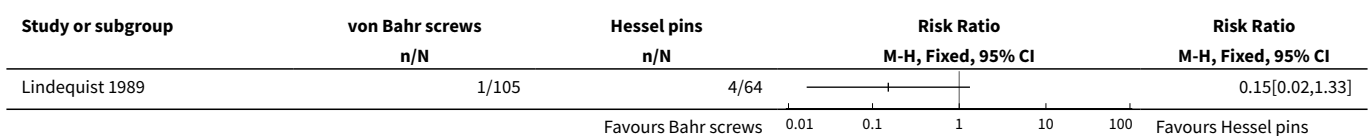
Analysis 7.4. Comparison 7 von Bahr screws versus Hessel pins, Outcome 4 Re-operations - arthroplasty.



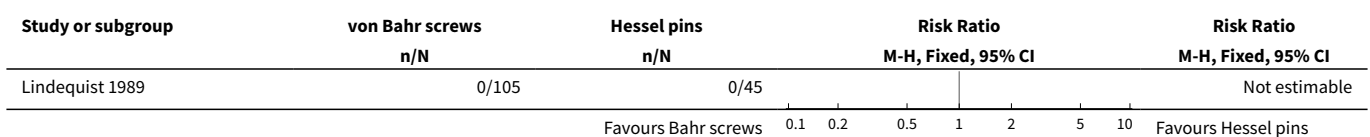
Analysis 7.5. Comparison 7 von Bahr screws versus Hessel pins, Outcome 5 Re-operations - implant removal.



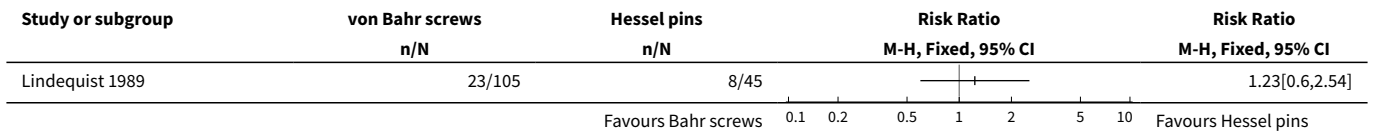
Analysis 7.6. Comparison 7 von Bahr screws versus Hessel pins, Outcome 6 Superficial wound infection.



Analysis 7.7. Comparison 7 von Bahr screws versus Hessel pins, Outcome 7 Deep wound infection.



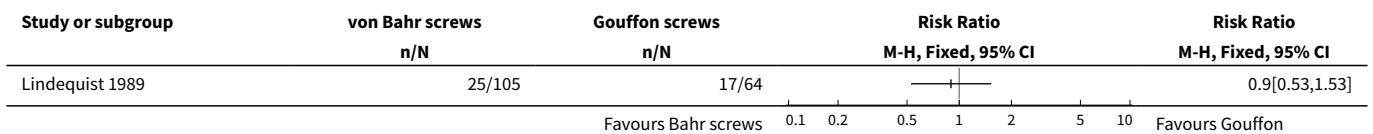
Analysis 7.8. Comparison 7 von Bahr screws versus Hessel pins, Outcome 8 Mortality - 2 years.



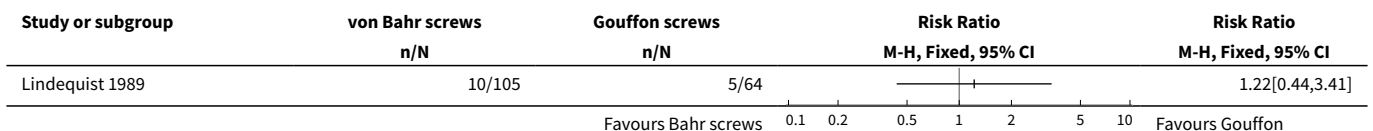
Comparison 8. von Bahr screws versus Gouffon screws

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Re-operations - arthroplasty	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Re-operations - implant removal	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6 Superficial wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7 Deep wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
8 Mortality - 2 years	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

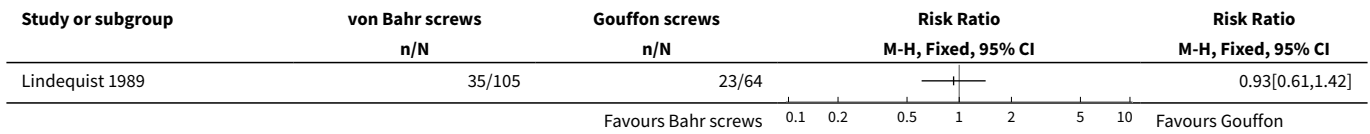
Analysis 8.1. Comparison 8 von Bahr screws versus Gouffon screws, Outcome 1 Non-union.



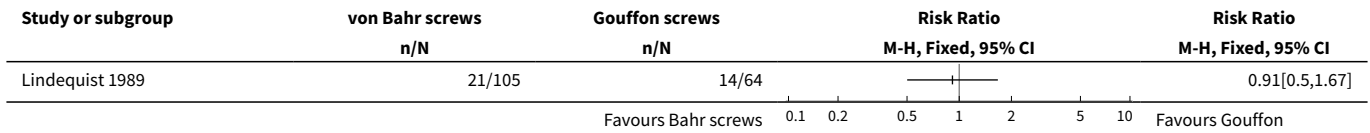
Analysis 8.2. Comparison 8 von Bahr screws versus Gouffon screws, Outcome 2 Avascular necrosis.



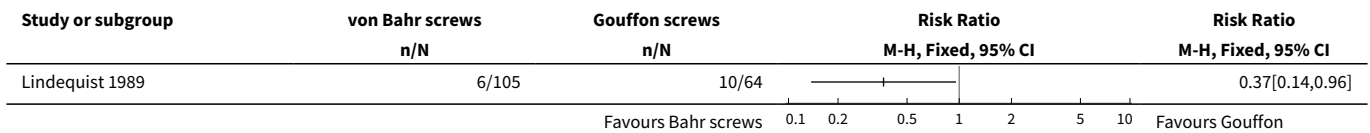
Analysis 8.3. Comparison 8 von Bahr screws versus Gouffon screws, Outcome 3 All fracture healing complications.



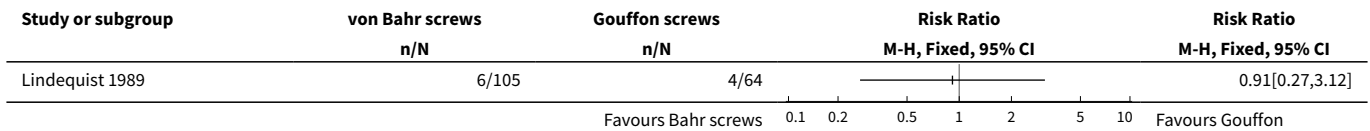
Analysis 8.4. Comparison 8 von Bahr screws versus Gouffon screws, Outcome 4 Re-operations - arthroplasty.



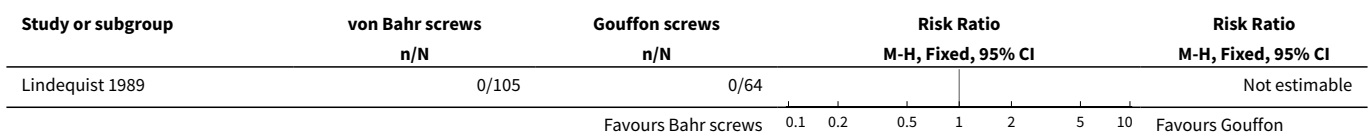
Analysis 8.5. Comparison 8 von Bahr screws versus Gouffon screws, Outcome 5 Re-operations - implant removal.



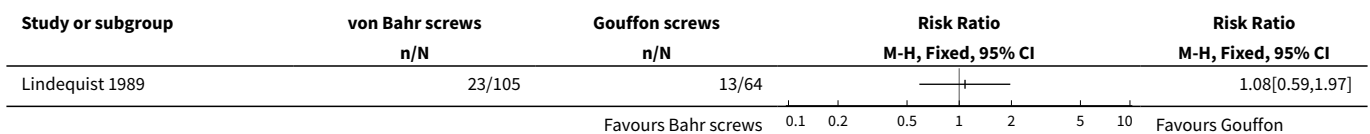
Analysis 8.6. Comparison 8 von Bahr screws versus Gouffon screws, Outcome 6 Superficial wound infection.



Analysis 8.7. Comparison 8 von Bahr screws versus Gouffon screws, Outcome 7 Deep wound infection.



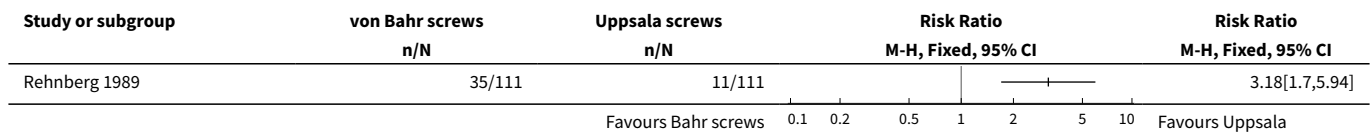
Analysis 8.8. Comparison 8 von Bahr screws versus Gouffon screws, Outcome 8 Mortality - 2 years.



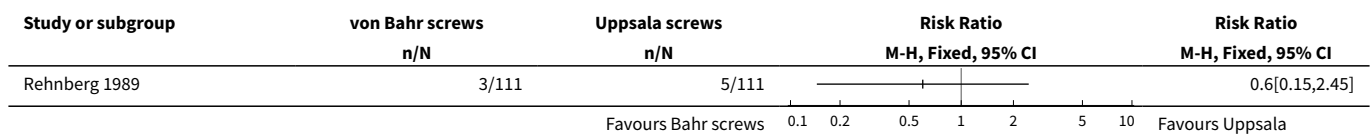
Comparison 9. Two von Bahr screws versus two Uppsala screws

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Re-operations - arthroplasty	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Re-operations - implant removal	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6 Mortality - 12 months	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

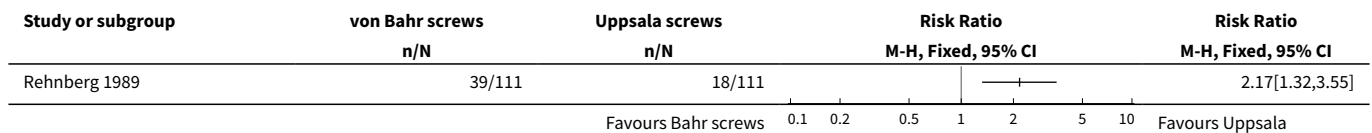
Analysis 9.1. Comparison 9 Two von Bahr screws versus two Uppsala screws, Outcome 1 Non-union.



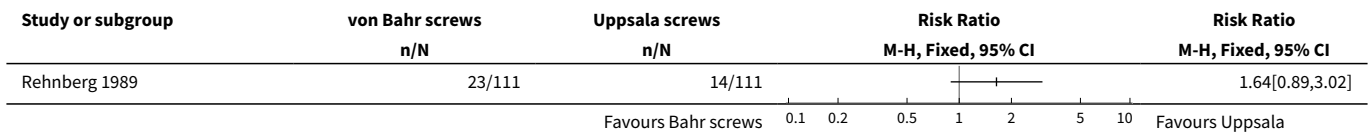
Analysis 9.2. Comparison 9 Two von Bahr screws versus two Uppsala screws, Outcome 2 Avascular necrosis.



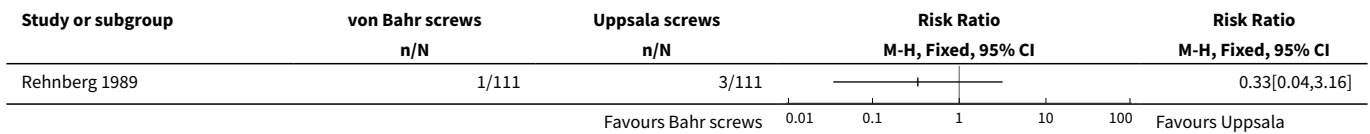
Analysis 9.3. Comparison 9 Two von Bahr screws versus two Uppsala screws, Outcome 3 All fracture healing complications.



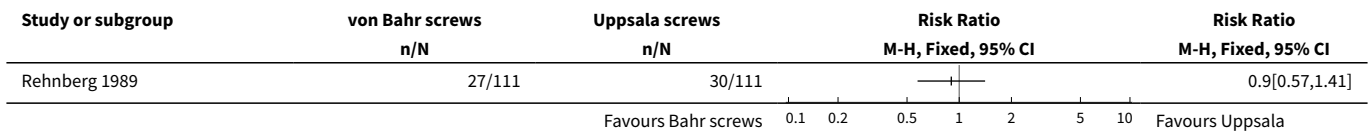
Analysis 9.4. Comparison 9 Two von Bahr screws versus two Uppsala screws, Outcome 4 Re-operations - arthroplasty.



Analysis 9.5. Comparison 9 Two von Bahr screws versus two Uppsala screws, Outcome 5 Re-operations - implant removal.



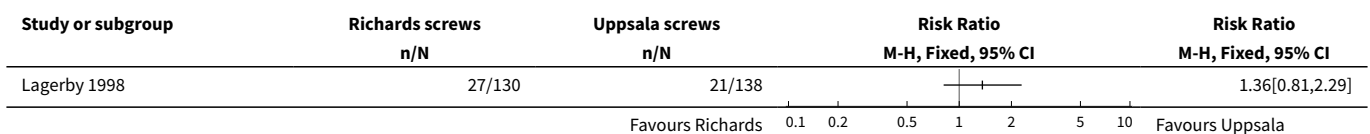
Analysis 9.6. Comparison 9 Two von Bahr screws versus two Uppsala screws, Outcome 6 Mortality - 12 months.



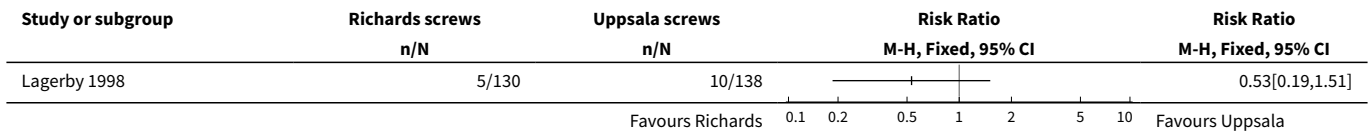
Comparison 10. Three Richards screws versus two Uppsala screws

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Pain (moderate/severe) at one year	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

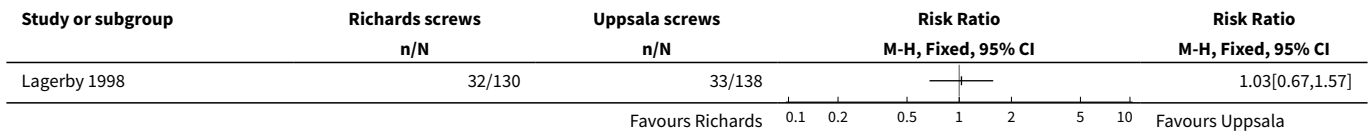
Analysis 10.1. Comparison 10 Three Richards screws versus two Uppsala screws, Outcome 1 Non-union.



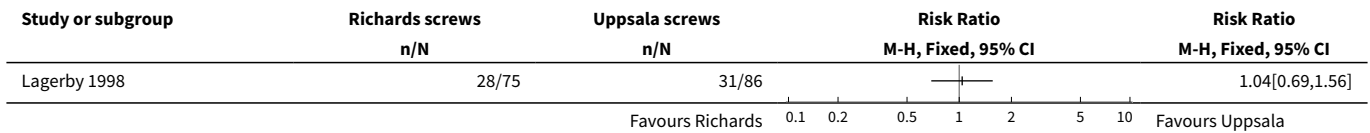
Analysis 10.2. Comparison 10 Three Richards screws versus two Uppsala screws, Outcome 2 Avascular necrosis.



Analysis 10.3. Comparison 10 Three Richards screws versus two Uppsala screws, Outcome 3 All fracture healing complications.



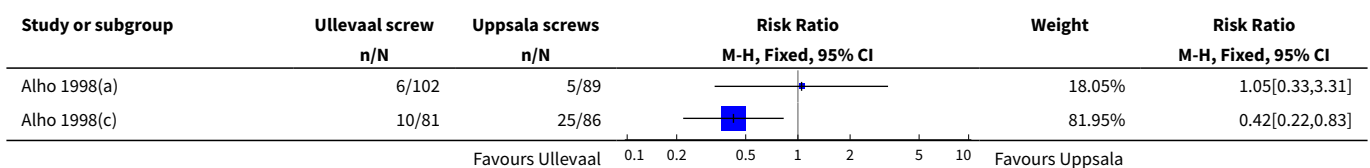
Analysis 10.4. Comparison 10 Three Richards screws versus two Uppsala screws, Outcome 4 Pain (moderate/severe) at one year.

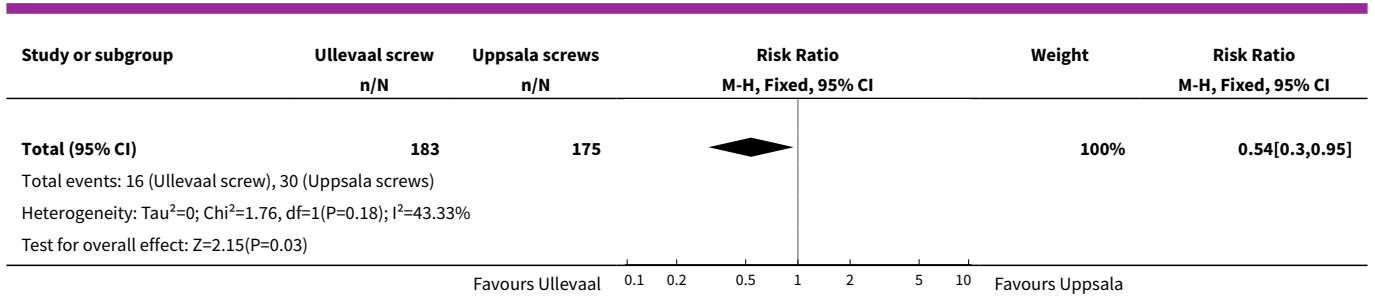


Comparison 11. Three Ullevaal screws versus two Uppsala/Olmed screws

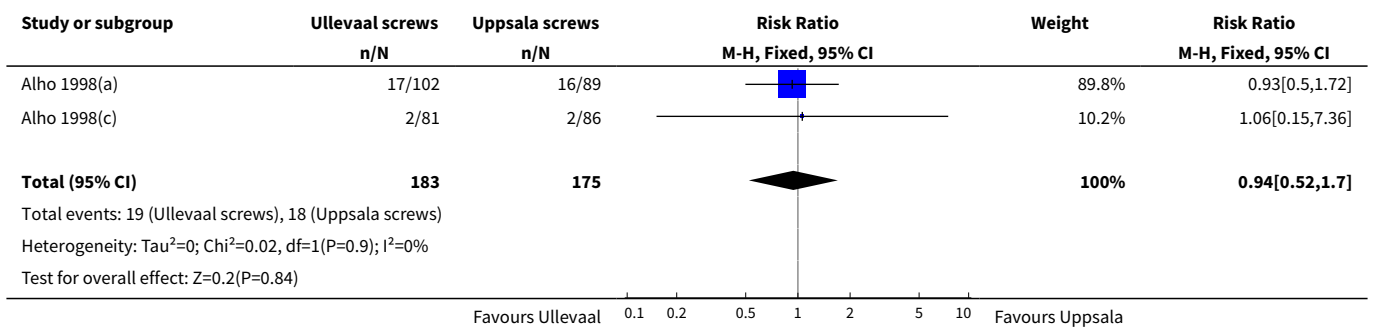
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Re-operations - arthroplasty	2	358	Risk Ratio (M-H, Fixed, 95% CI)	0.54 [0.30, 0.95]
2 Re-operations - implant removal	2	358	Risk Ratio (M-H, Fixed, 95% CI)	0.94 [0.52, 1.70]
3 Fracture below screws (requiring re-operation)	2	358	Risk Ratio (M-H, Fixed, 95% CI)	2.19 [0.33, 14.53]

Analysis 11.1. Comparison 11 Three Ullevaal screws versus two Uppsala/Olmed screws, Outcome 1 Re-operations - arthroplasty.

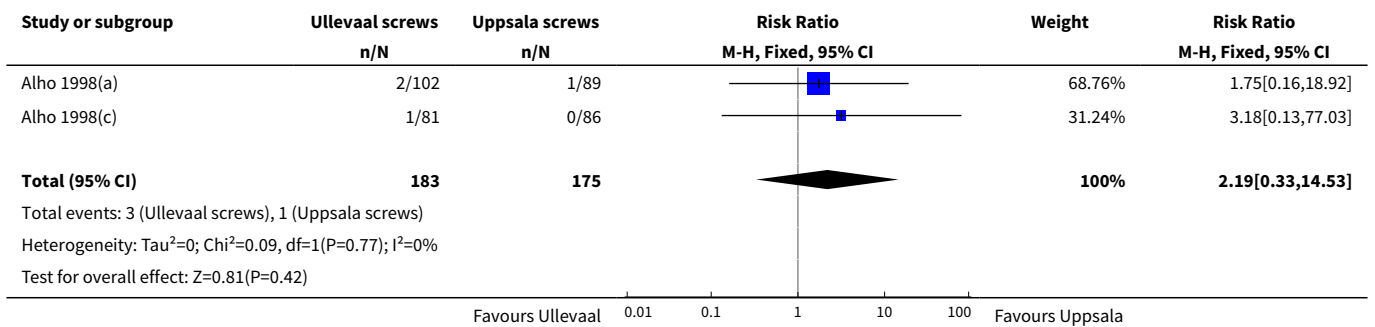




Analysis 11.2. Comparison 11 Three Ullevaal screws versus two Uppsala/Olmed screws, Outcome 2 Re-operations - implant removal.



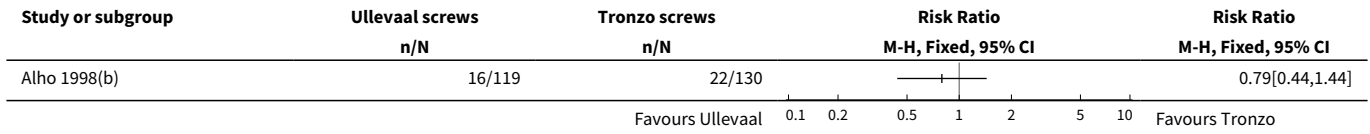
Analysis 11.3. Comparison 11 Three Ullevaal screws versus two Uppsala/Olmed screws, Outcome 3 Fracture below screws (requiring re-operation).



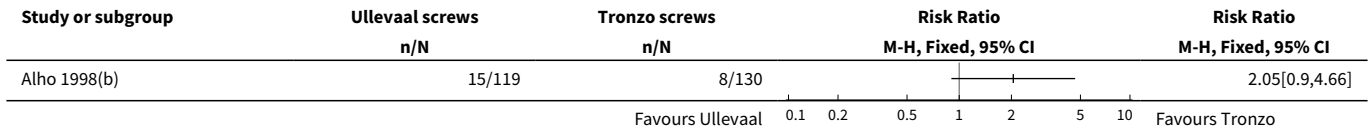
Comparison 12. Three Ullevaal screws versus two Tronzo screws

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Re-operations - arthroplasty	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Re-operations - implant removal	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 Fracture below screws (requiring re-operation)	1		Peto Odds Ratio (Peto, Fixed, 95% CI)	Totals not selected

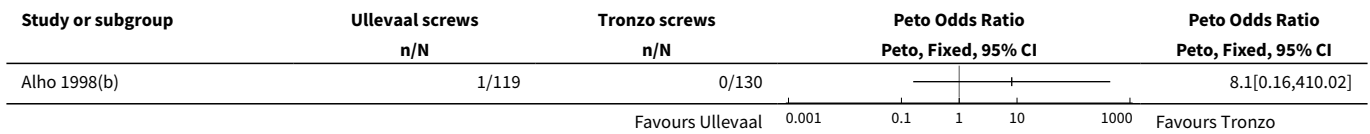
Analysis 12.1. Comparison 12 Three Ullevaal screws versus two Tronzo screws, Outcome 1 Re-operations - arthroplasty.



Analysis 12.2. Comparison 12 Three Ullevaal screws versus two Tronzo screws, Outcome 2 Re-operations - implant removal.



Analysis 12.3. Comparison 12 Three Ullevaal screws versus two Tronzo screws, Outcome 3 Fracture below screws (requiring re-operation).

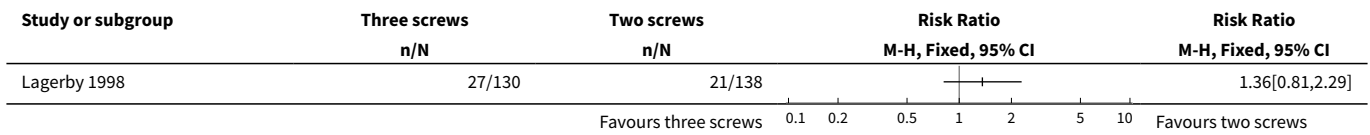


Comparison 13. Three screws (any type) versus two screws (any type)

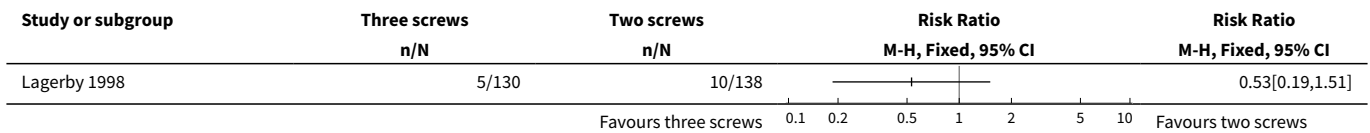
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Re-operations - arthroplasty	3	607	Risk Ratio (M-H, Fixed, 95% CI)	0.64 [0.43, 0.97]
5 Re-operations - implant removal	3	607	Risk Ratio (M-H, Fixed, 95% CI)	1.26 [0.78, 2.02]
6 Fracture below screws (requiring re-operation)	3	607	Risk Ratio (M-H, Fixed, 95% CI)	2.45 [0.48, 12.38]
7 Re-operation for arthroplasty or non-union	4	875	Risk Ratio (M-H, Fixed, 95% CI)	0.85 [0.62, 1.17]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8 Pain (moderate/severe) at one year	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

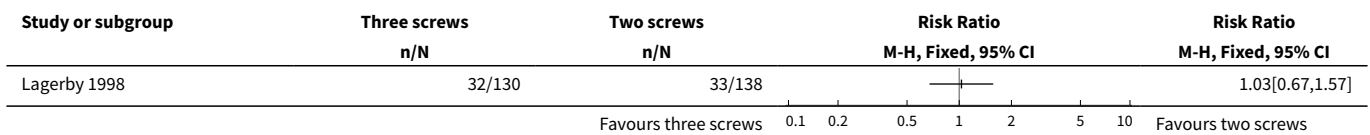
Analysis 13.1. Comparison 13 Three screws (any type) versus two screws (any type), Outcome 1 Non-union.



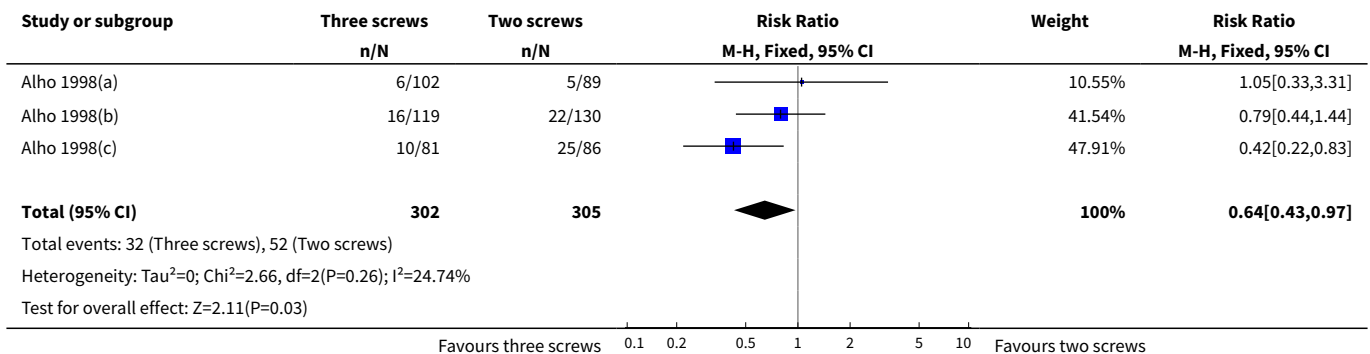
Analysis 13.2. Comparison 13 Three screws (any type) versus two screws (any type), Outcome 2 Avascular necrosis.



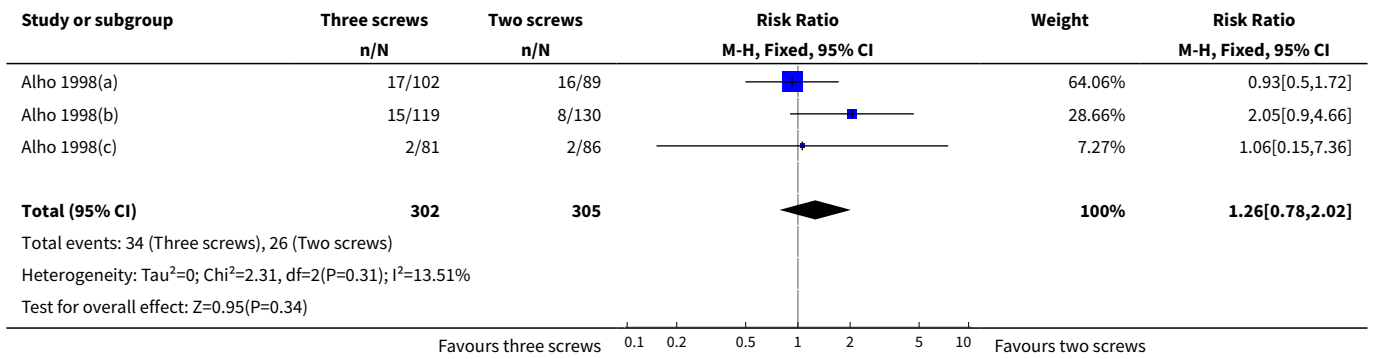
Analysis 13.3. Comparison 13 Three screws (any type) versus two screws (any type), Outcome 3 All fracture healing complications.



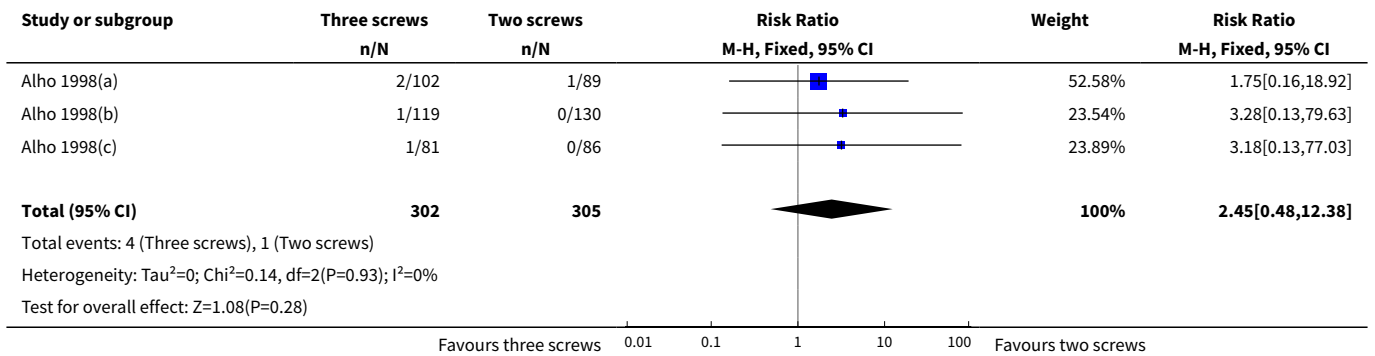
Analysis 13.4. Comparison 13 Three screws (any type) versus two screws (any type), Outcome 4 Re-operations - arthroplasty.



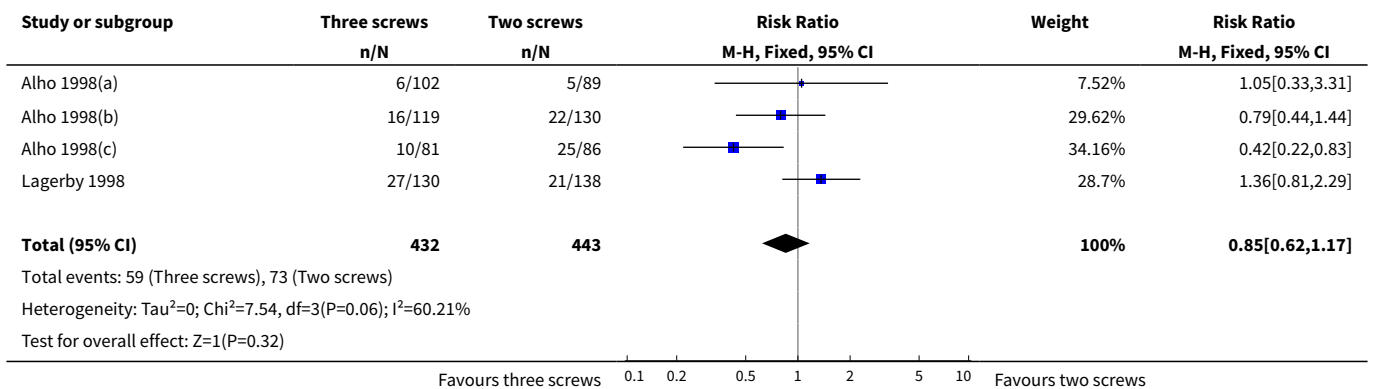
Analysis 13.5. Comparison 13 Three screws (any type) versus two screws (any type), Outcome 5 Re-operations - implant removal.



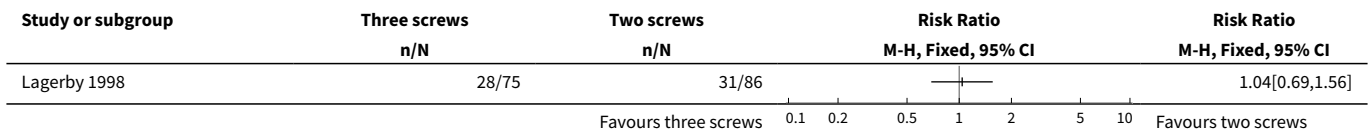
Analysis 13.6. Comparison 13 Three screws (any type) versus two screws (any type), Outcome 6 Fracture below screws (requiring re-operation).



Analysis 13.7. Comparison 13 Three screws (any type) versus two screws (any type), Outcome 7 Re-operation for arthroplasty or non-union.



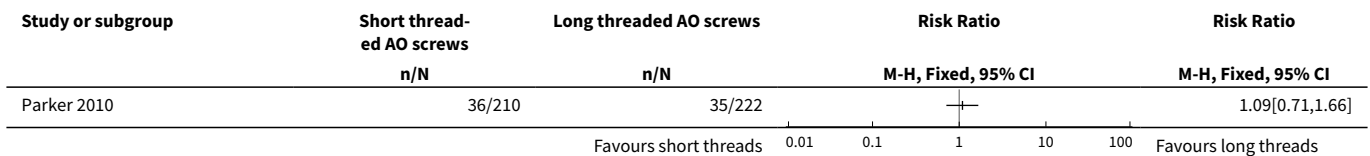
Analysis 13.8. Comparison 13 Three screws (any type) versus two screws (any type), Outcome 8 Pain (moderate/severe) at one year.



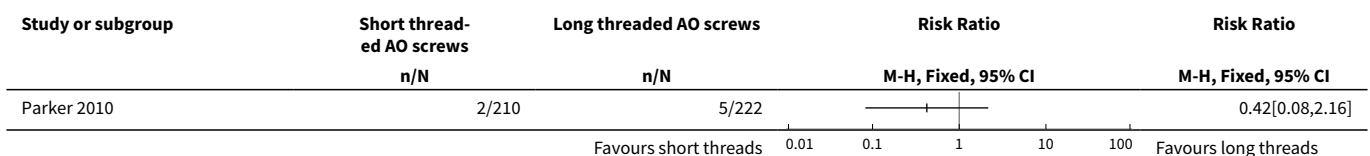
Comparison 14. Three short thread AO screws versus three long threaded AO screws

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 Fracture below screws	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Re-operations - all types	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Re-operations - implant removal	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6 Mortality - one year	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7 Pain at one year follow-up	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
8 Failure to return to same residential status at one year (survivors)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

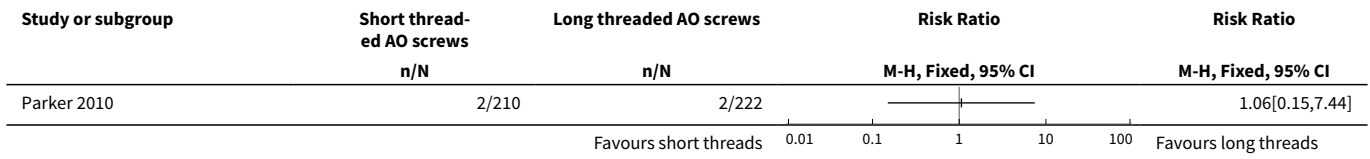
Analysis 14.1. Comparison 14 Three short thread AO screws versus three long threaded AO screws, Outcome 1 Non-union.



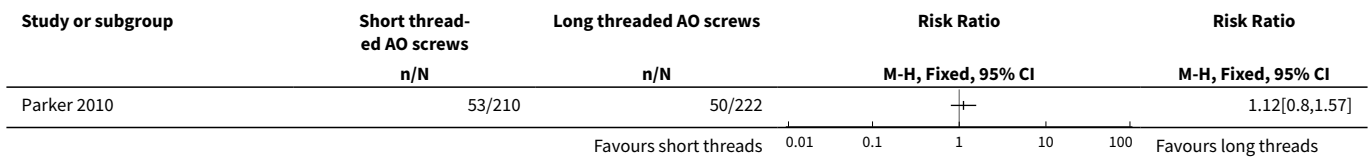
Analysis 14.2. Comparison 14 Three short thread AO screws versus three long threaded AO screws, Outcome 2 Avascular necrosis.



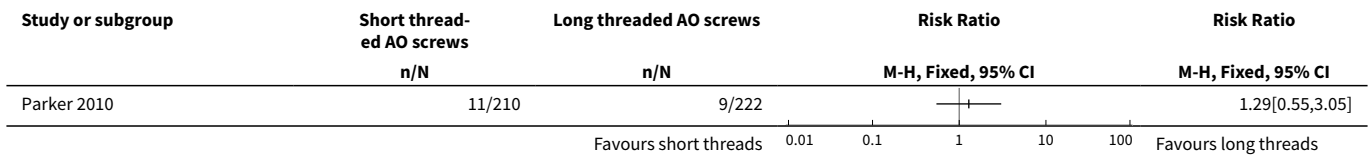
Analysis 14.3. Comparison 14 Three short thread AO screws versus three long threaded AO screws, Outcome 3 Fracture below screws.



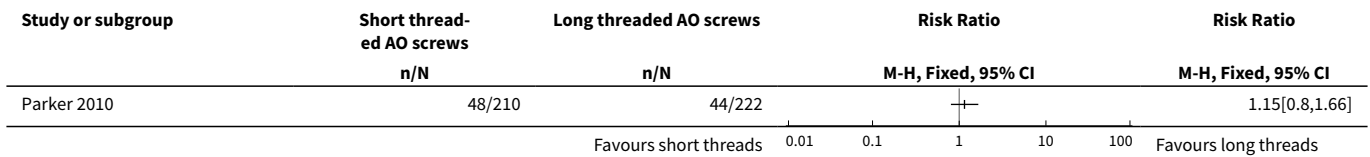
Analysis 14.4. Comparison 14 Three short thread AO screws versus three long threaded AO screws, Outcome 4 Re-operations - all types.



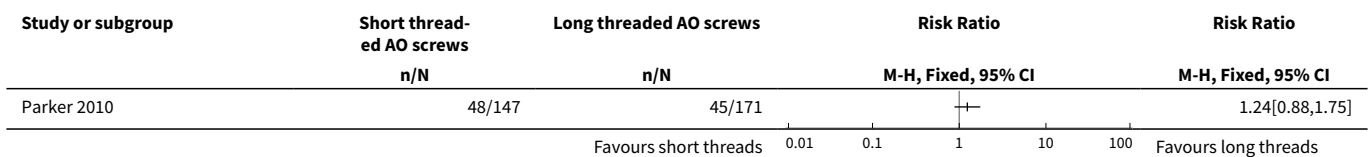
Analysis 14.5. Comparison 14 Three short thread AO screws versus three long threaded AO screws, Outcome 5 Re-operations - implant removal.



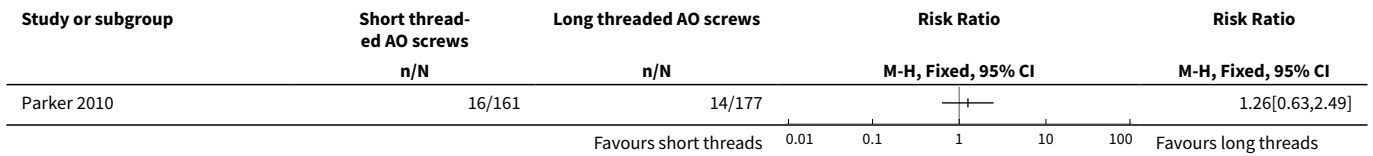
Analysis 14.6. Comparison 14 Three short thread AO screws versus three long threaded AO screws, Outcome 6 Mortality - one year.



Analysis 14.7. Comparison 14 Three short thread AO screws versus three long threaded AO screws, Outcome 7 Pain at one year follow-up.



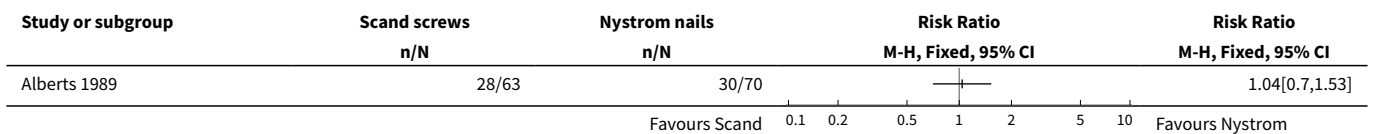
Analysis 14.8. Comparison 14 Three short thread AO screws versus three long threaded AO screws, Outcome 8 Failure to return to same residential status at one year (survivors).



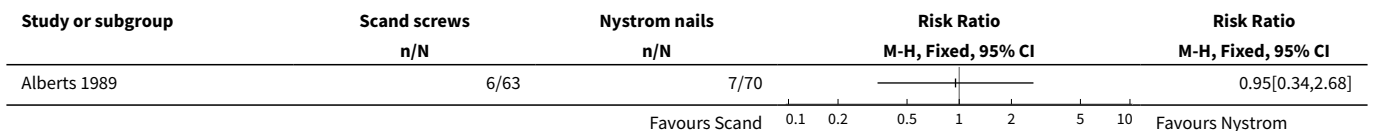
Comparison 15. Three Scand screws versus three Nystrom nails

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4 Superficial wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Deep wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6 Mortality - one year	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7 Mortality - two years	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

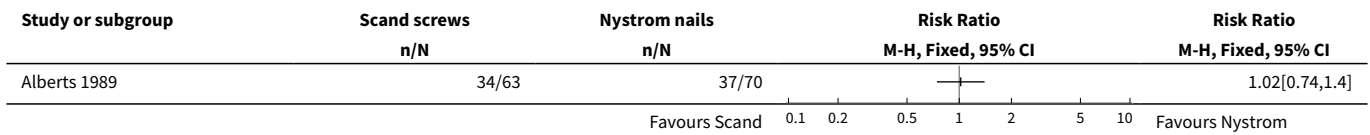
Analysis 15.1. Comparison 15 Three Scand screws versus three Nystrom nails, Outcome 1 Non-union.



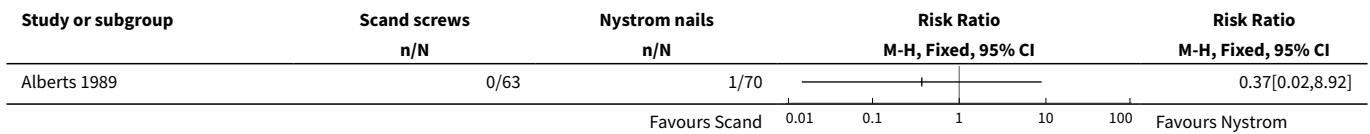
Analysis 15.2. Comparison 15 Three Scand screws versus three Nystrom nails, Outcome 2 Avascular necrosis.



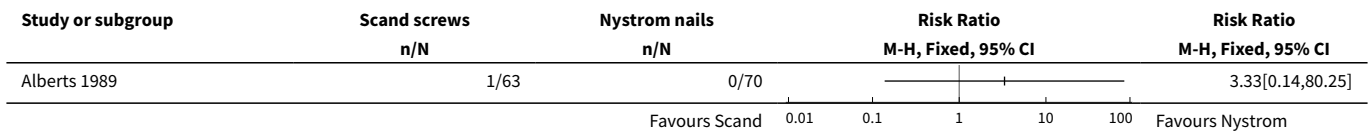
Analysis 15.3. Comparison 15 Three Scand screws versus three Nystrom nails, Outcome 3 All fracture healing complications.



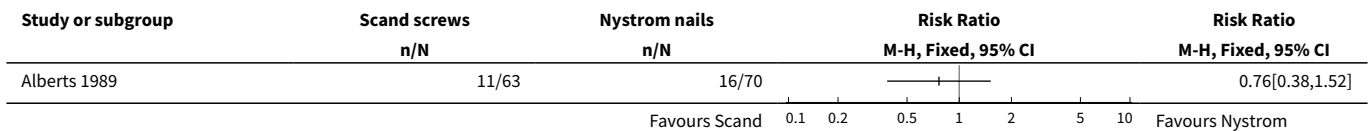
Analysis 15.4. Comparison 15 Three Scand screws versus three Nystrom nails, Outcome 4 Superficial wound infection.



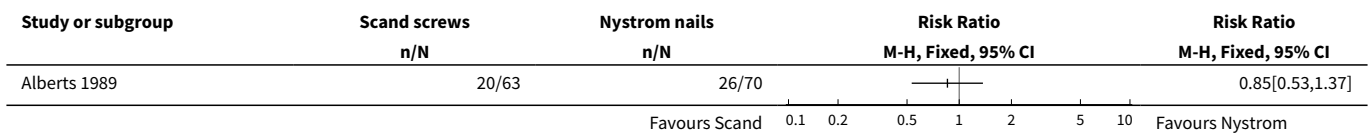
Analysis 15.5. Comparison 15 Three Scand screws versus three Nystrom nails, Outcome 5 Deep wound infection.



Analysis 15.6. Comparison 15 Three Scand screws versus three Nystrom nails, Outcome 6 Mortality - one year.



Analysis 15.7. Comparison 15 Three Scand screws versus three Nystrom nails, Outcome 7 Mortality - two years.

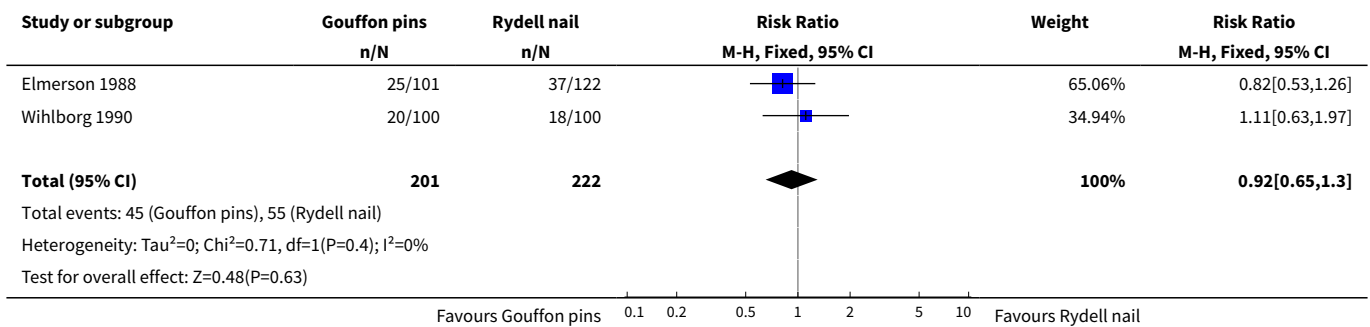


Comparison 16. Three Gouffon screws versus Rydell four-flanged nail

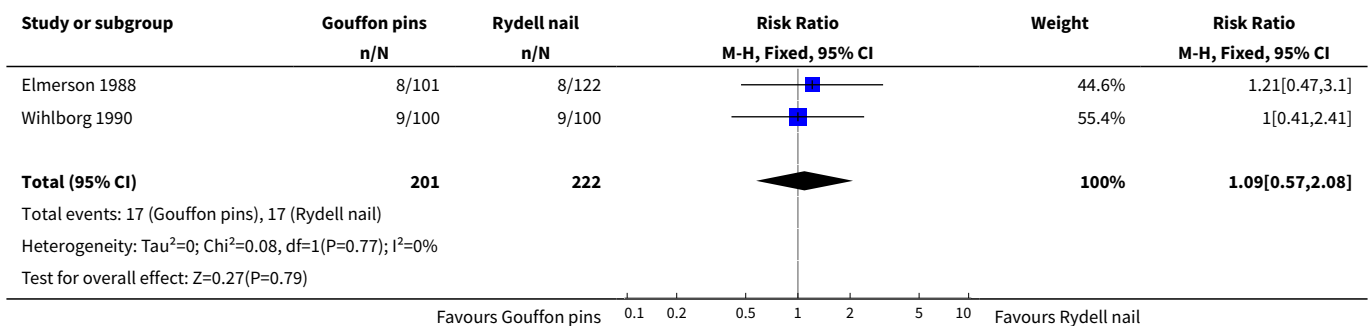
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	2	423	Risk Ratio (M-H, Fixed, 95% CI)	0.92 [0.65, 1.30]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Avascular necrosis	2	423	Risk Ratio (M-H, Fixed, 95% CI)	1.09 [0.57, 2.08]
3 All fracture healing complications	2	423	Risk Ratio (M-H, Fixed, 95% CI)	0.96 [0.73, 1.27]
4 Re-operations	2	423	Risk Ratio (M-H, Fixed, 95% CI)	1.12 [0.74, 1.71]
5 Superficial wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6 Deep wound infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7 Mortality - one year	2	423	Risk Ratio (M-H, Fixed, 95% CI)	1.13 [0.66, 1.94]
8 Mortality - two years	2	423	Risk Ratio (M-H, Fixed, 95% CI)	0.87 [0.60, 1.28]

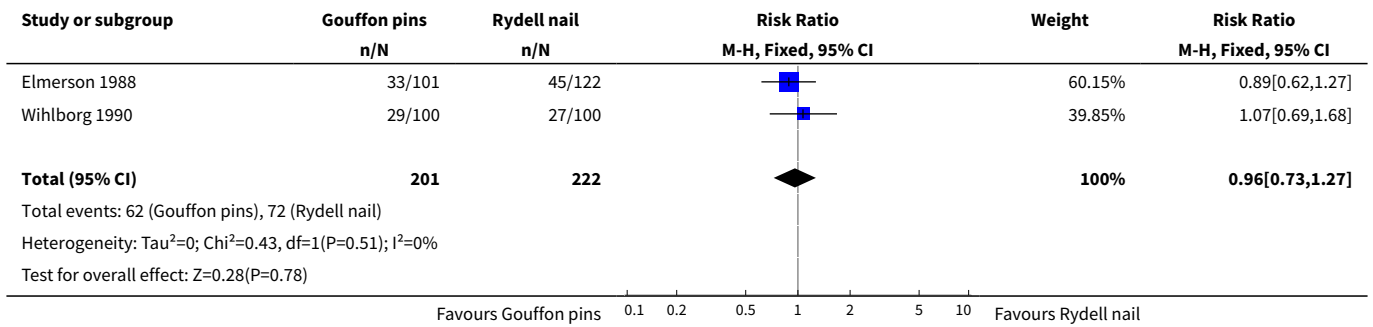
Analysis 16.1. Comparison 16 Three Gouffon screws versus Rydell four-flanged nail, Outcome 1 Non-union.



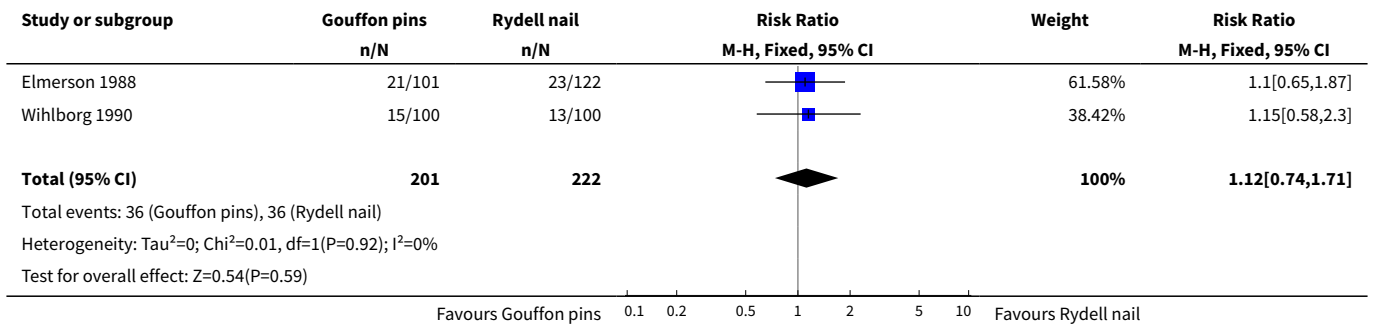
Analysis 16.2. Comparison 16 Three Gouffon screws versus Rydell four-flanged nail, Outcome 2 Avascular necrosis.



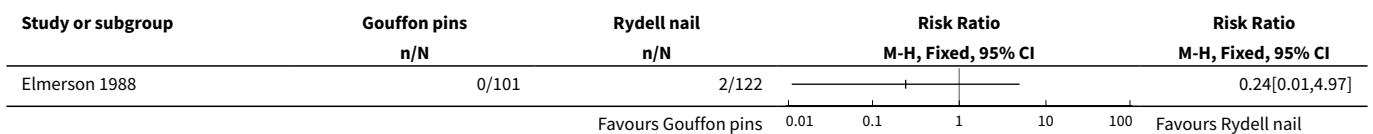
Analysis 16.3. Comparison 16 Three Gouffon screws versus Rydell four-flanged nail, Outcome 3 All fracture healing complications.



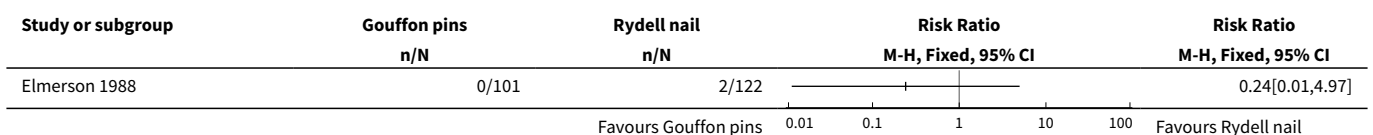
Analysis 16.4. Comparison 16 Three Gouffon screws versus Rydell four-flanged nail, Outcome 4 Re-operations.



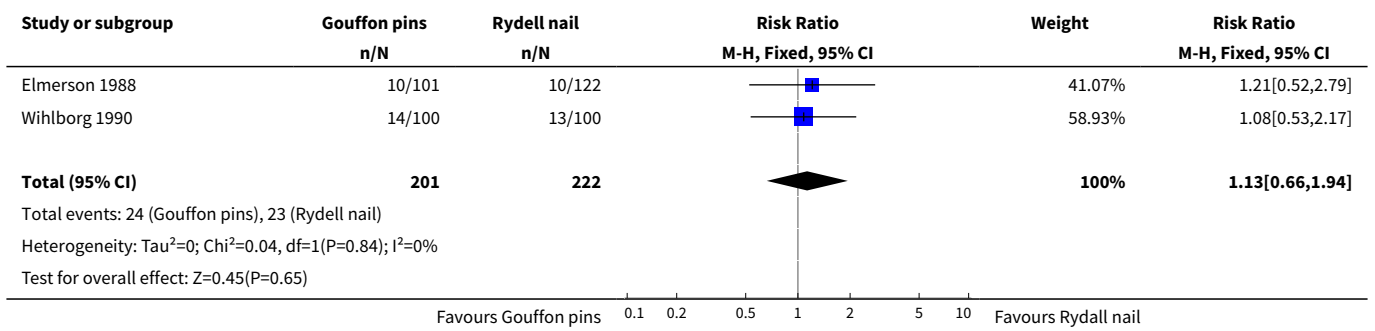
Analysis 16.5. Comparison 16 Three Gouffon screws versus Rydell four-flanged nail, Outcome 5 Superficial wound infection.



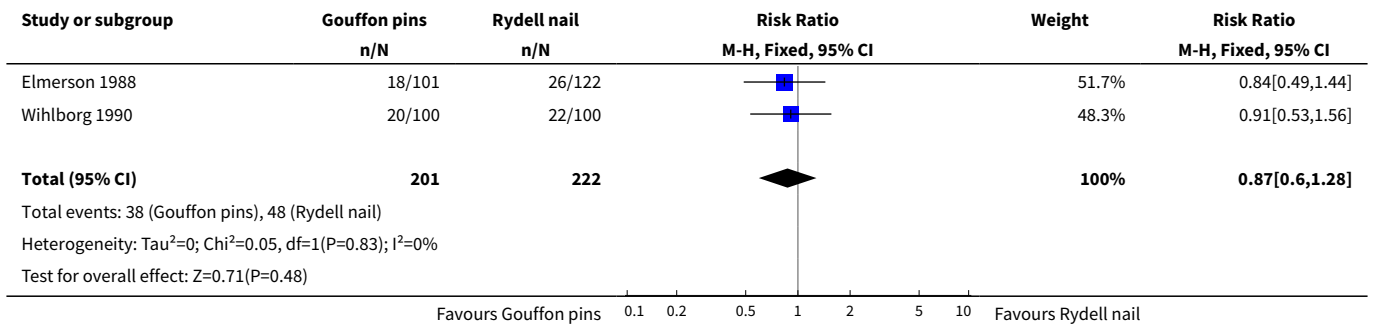
Analysis 16.6. Comparison 16 Three Gouffon screws versus Rydell four-flanged nail, Outcome 6 Deep wound infection.



Analysis 16.7. Comparison 16 Three Gouffon screws versus Rydell four-flanged nail, Outcome 7 Mortality - one year.



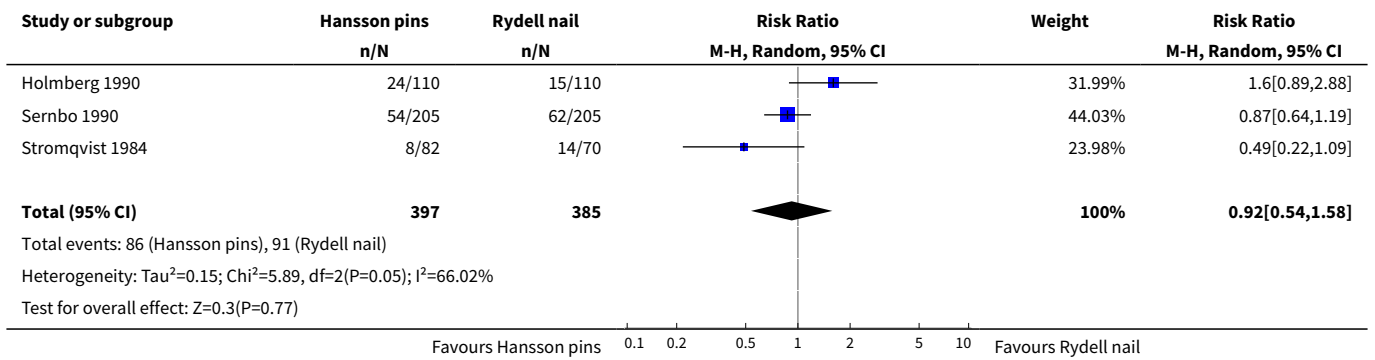
Analysis 16.8. Comparison 16 Three Gouffon screws versus Rydell four-flanged nail, Outcome 8 Mortality - two years.



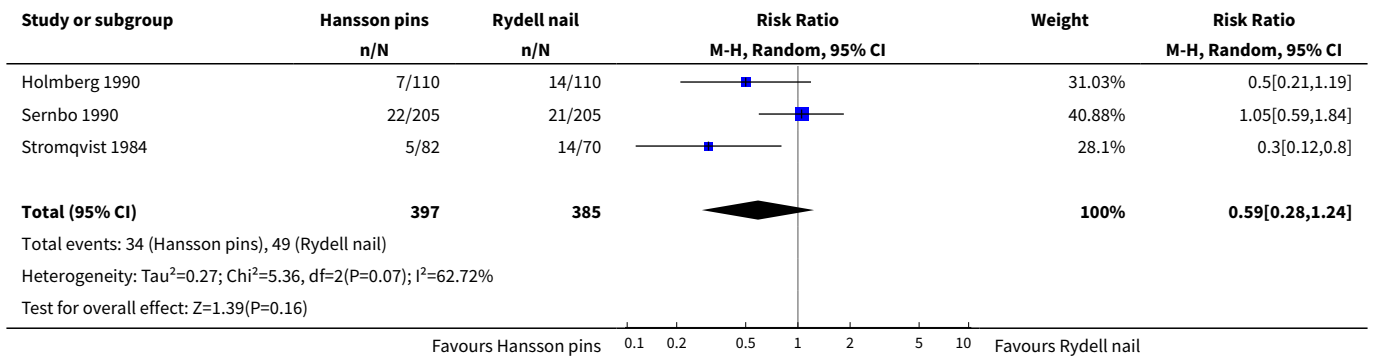
Comparison 17. Two Hansson pins versus Rydell four-flanged nail

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	3	782	Risk Ratio (M-H, Random, 95% CI)	0.92 [0.54, 1.58]
2 Avascular necrosis	3	782	Risk Ratio (M-H, Random, 95% CI)	0.59 [0.28, 1.24]
3 All fracture healing complications	3	782	Risk Ratio (M-H, Random, 95% CI)	0.77 [0.48, 1.23]
4 Re-operations - arthroplasty	3	782	Risk Ratio (M-H, Random, 95% CI)	0.83 [0.43, 1.61]
5 Re-operations - implant removal	2	630	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.51, 1.96]
6 Mortality - 2 years	2	372	Risk Ratio (M-H, Fixed, 95% CI)	1.10 [0.81, 1.48]

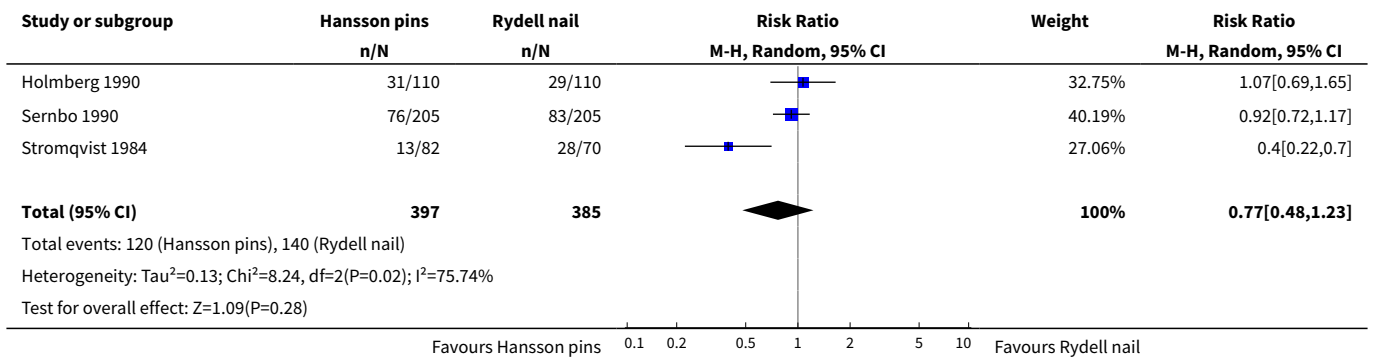
Analysis 17.1. Comparison 17 Two Hansson pins versus Rydell four-flanged nail, Outcome 1 Non-union.



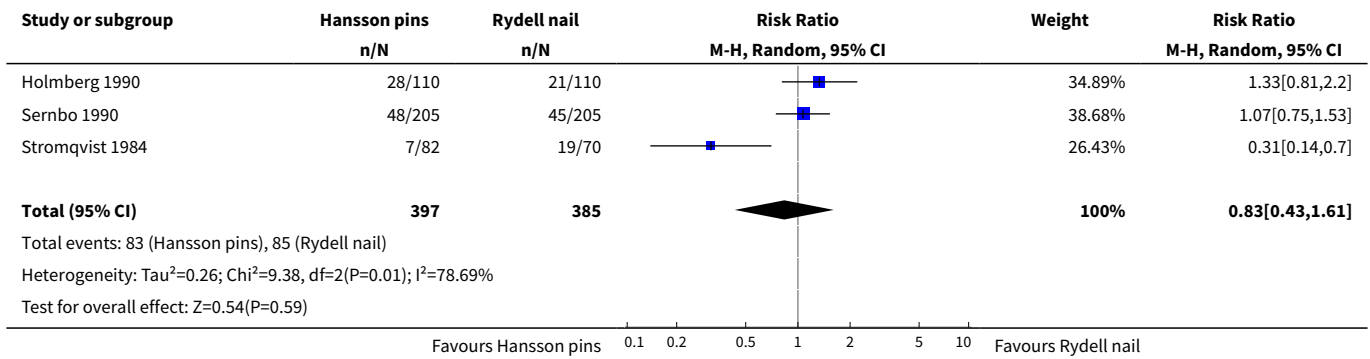
Analysis 17.2. Comparison 17 Two Hansson pins versus Rydell four-flanged nail, Outcome 2 Avascular necrosis.



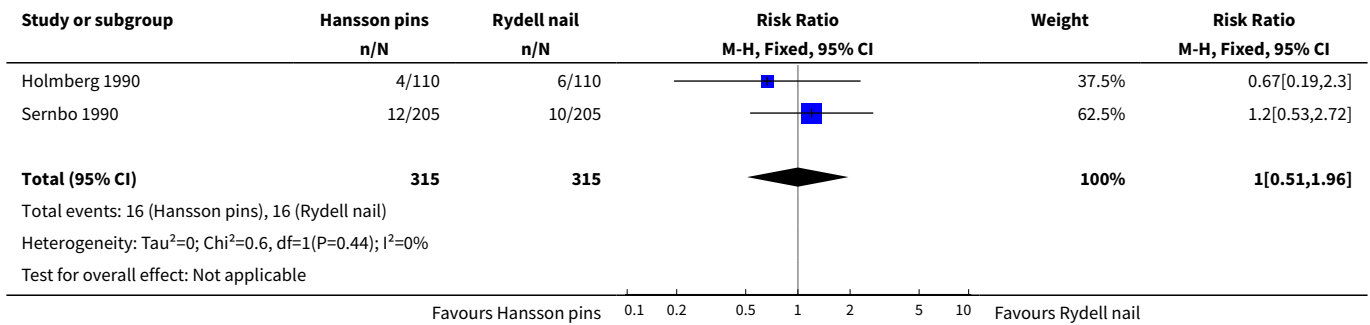
Analysis 17.3. Comparison 17 Two Hansson pins versus Rydell four-flanged nail, Outcome 3 All fracture healing complications.



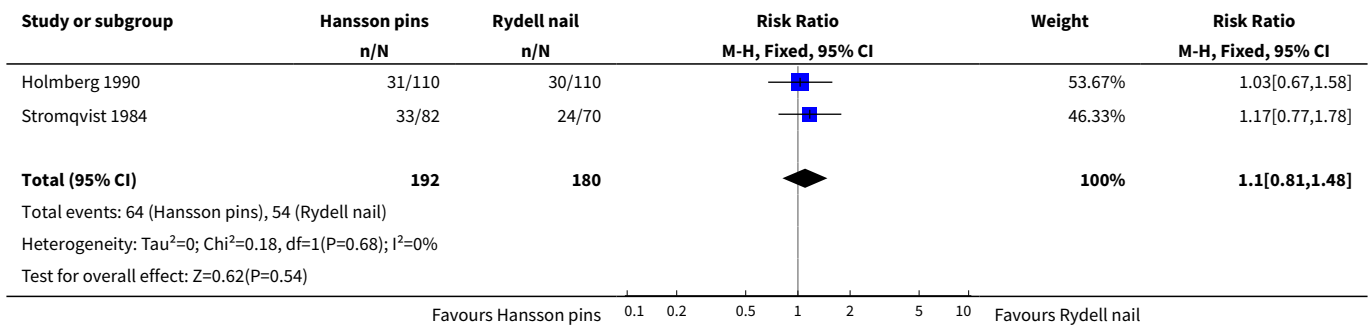
Analysis 17.4. Comparison 17 Two Hansson pins versus Rydell four-flanged nail, Outcome 4 Re-operations - arthroplasty.



Analysis 17.5. Comparison 17 Two Hansson pins versus Rydell four-flanged nail, Outcome 5 Re-operations - implant removal.



Analysis 17.6. Comparison 17 Two Hansson pins versus Rydell four-flanged nail, Outcome 6 Mortality - 2 years.

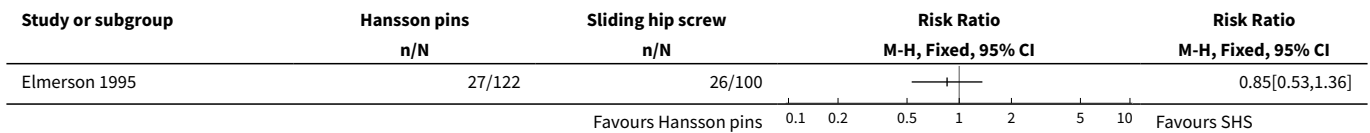


Comparison 18. Two Hansson pins versus sliding hip screw

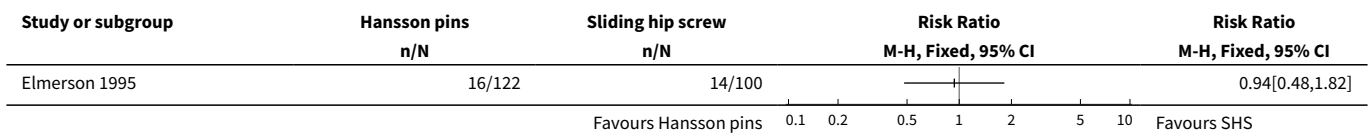
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Avascular necrosis	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3 All fracture healing complications	2	321	Risk Ratio (M-H, Fixed, 95% CI)	0.93 [0.70, 1.25]
4 Re-operations - arthroplasty	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5 Mortality - 2 years	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6 Length of surgery	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

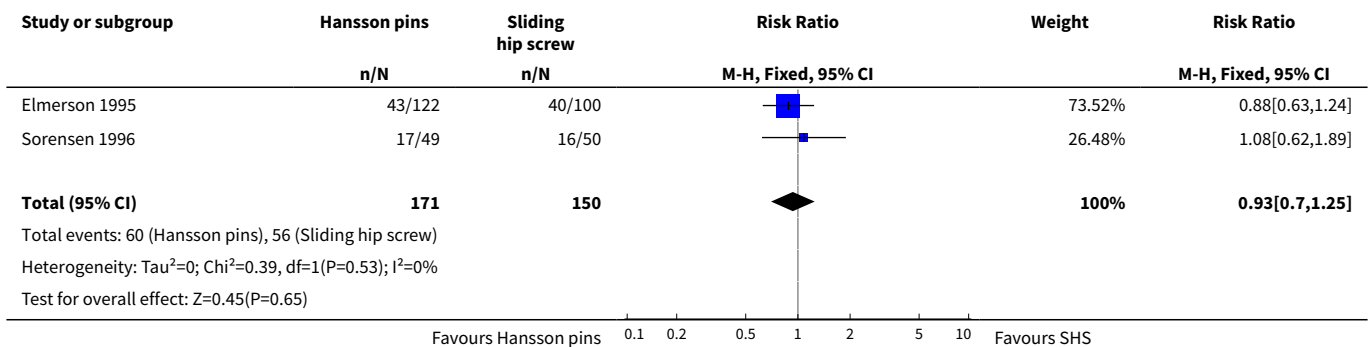
Analysis 18.1. Comparison 18 Two Hansson pins versus sliding hip screw, Outcome 1 Non-union.



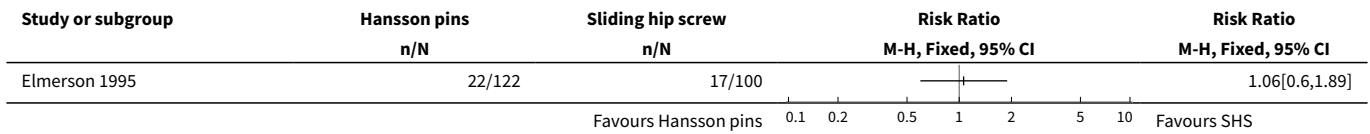
Analysis 18.2. Comparison 18 Two Hansson pins versus sliding hip screw, Outcome 2 Avascular necrosis.



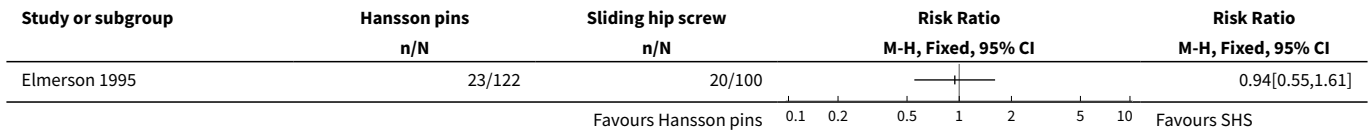
Analysis 18.3. Comparison 18 Two Hansson pins versus sliding hip screw, Outcome 3 All fracture healing complications.



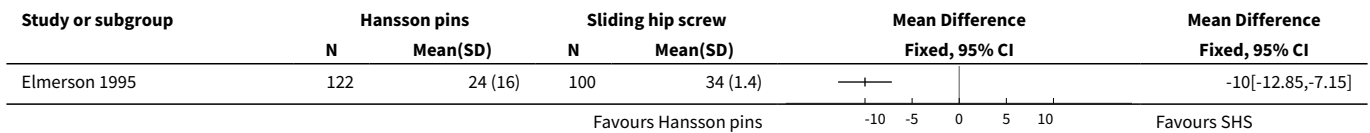
Analysis 18.4. Comparison 18 Two Hansson pins versus sliding hip screw, Outcome 4 Re-operations - arthroplasty.



Analysis 18.5. Comparison 18 Two Hansson pins versus sliding hip screw, Outcome 5 Mortality - 2 years.



Analysis 18.6. Comparison 18 Two Hansson pins versus sliding hip screw, Outcome 6 Length of surgery.



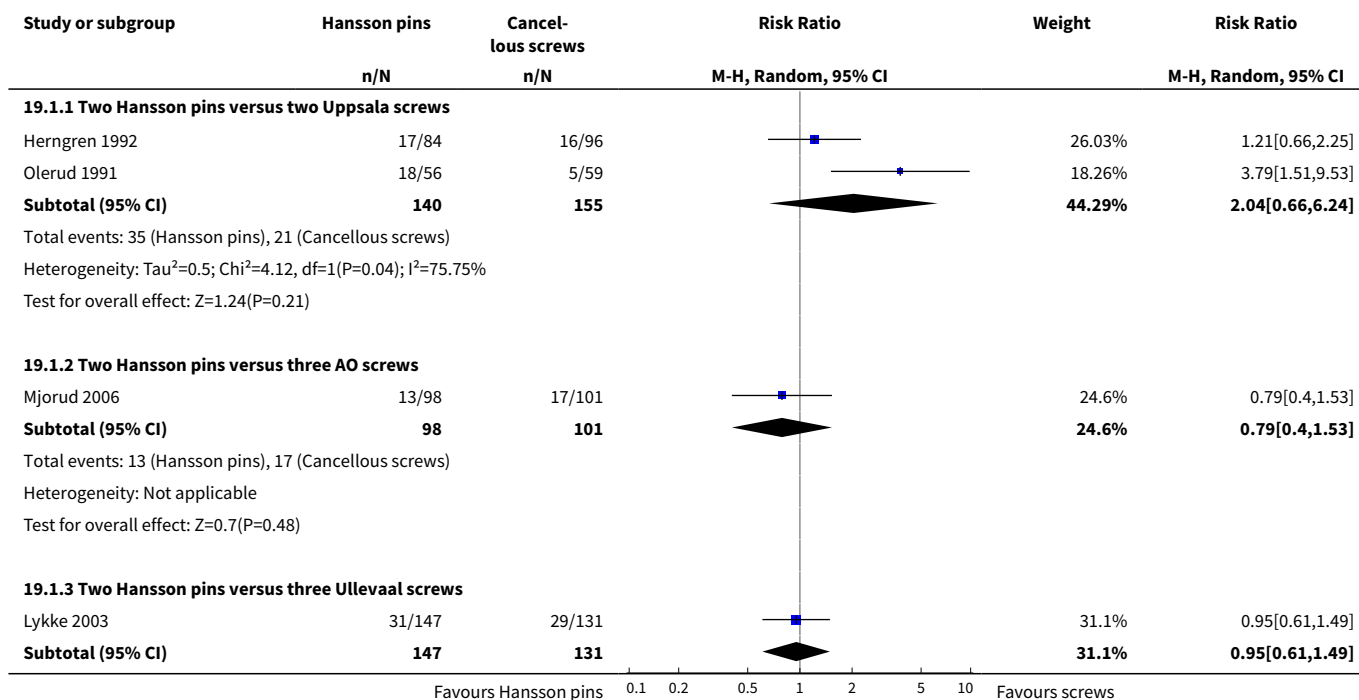
Comparison 19. Two Hansson pins versus cancellous screws

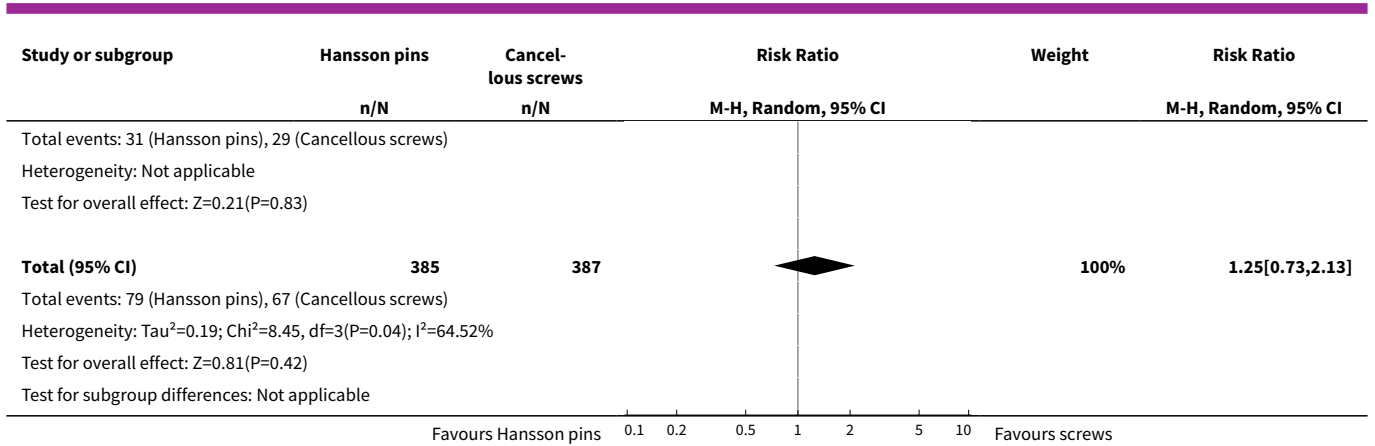
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-union	4	772	Risk Ratio (M-H, Random, 95% CI)	1.25 [0.73, 2.13]
1.1 Two Hansson pins versus two Up-sala screws	2	295	Risk Ratio (M-H, Random, 95% CI)	2.04 [0.66, 6.24]
1.2 Two Hansson pins versus three AO screws	1	199	Risk Ratio (M-H, Random, 95% CI)	0.79 [0.40, 1.53]
1.3 Two Hansson pins versus three Ullevaal screws	1	278	Risk Ratio (M-H, Random, 95% CI)	0.95 [0.61, 1.49]
2 Avascular necrosis	4	772	Risk Ratio (M-H, Random, 95% CI)	0.94 [0.43, 2.05]
2.1 Two Hansson pins versus two Up-sala screws	2	295	Risk Ratio (M-H, Random, 95% CI)	1.49 [0.69, 3.21]
2.2 Two Hansson pins versus three AO screws	1	199	Risk Ratio (M-H, Random, 95% CI)	1.29 [0.36, 4.66]
2.3 Two Hansson pins versus three Ullevaal screws	1	278	Risk Ratio (M-H, Random, 95% CI)	0.48 [0.21, 1.08]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3 All fracture healing complications	5	872	Risk Ratio (M-H, Random, 95% CI)	1.14 [0.77, 1.67]
3.1 Two Hansson pins versus two Up-sala screws	3	395	Risk Ratio (M-H, Random, 95% CI)	1.50 [0.79, 2.84]
3.2 Two Hansson pins versus three AO screws	1	199	Risk Ratio (M-H, Random, 95% CI)	0.94 [0.56, 1.59]
3.3 Two Hansson pins versus three Ullevaal screws	1	278	Risk Ratio (M-H, Random, 95% CI)	0.79 [0.55, 1.13]
4 Re-operations - arthroplasty	3	587	Risk Ratio (M-H, Fixed, 95% CI)	0.74 [0.52, 1.04]
4.1 Two Hansson pins versus two cancellous AO	1	110	Risk Ratio (M-H, Fixed, 95% CI)	0.15 [0.02, 1.25]
4.2 Two Hansson pins versus three AO screws	1	199	Risk Ratio (M-H, Fixed, 95% CI)	0.76 [0.43, 1.34]
4.3 Two Hansson pins versus three Ullevaal screws	1	278	Risk Ratio (M-H, Fixed, 95% CI)	0.83 [0.53, 1.31]
5 Re-operation - arthroplasty or need for arthroplasty	3	587	Risk Ratio (M-H, Fixed, 95% CI)	0.80 [0.58, 1.12]
5.1 Two Hansson pins versus two cancellous AO	1	110	Risk Ratio (M-H, Fixed, 95% CI)	0.80 [0.29, 2.22]
5.2 Two Hansson pins versus three AO screws	1	199	Risk Ratio (M-H, Fixed, 95% CI)	0.76 [0.43, 1.34]
5.3 Two Hansson pins versus three Ullevaal screws	1	278	Risk Ratio (M-H, Fixed, 95% CI)	0.83 [0.53, 1.31]
6 Re-operations - implant removal	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.1 Two Hansson pins versus three AO screws	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
7 Re-operations - type not specified	2	379	Risk Ratio (M-H, Fixed, 95% CI)	1.05 [0.73, 1.51]
7.1 Two Hansson pins versus two Up-sala screws	1	180	Risk Ratio (M-H, Fixed, 95% CI)	1.33 [0.76, 2.33]
7.2 Two Hansson pins versus three AO screws	1	199	Risk Ratio (M-H, Fixed, 95% CI)	0.88 [0.54, 1.42]
8 Deep wound infection	2	458	Risk Ratio (M-H, Fixed, 95% CI)	0.76 [0.13, 4.45]

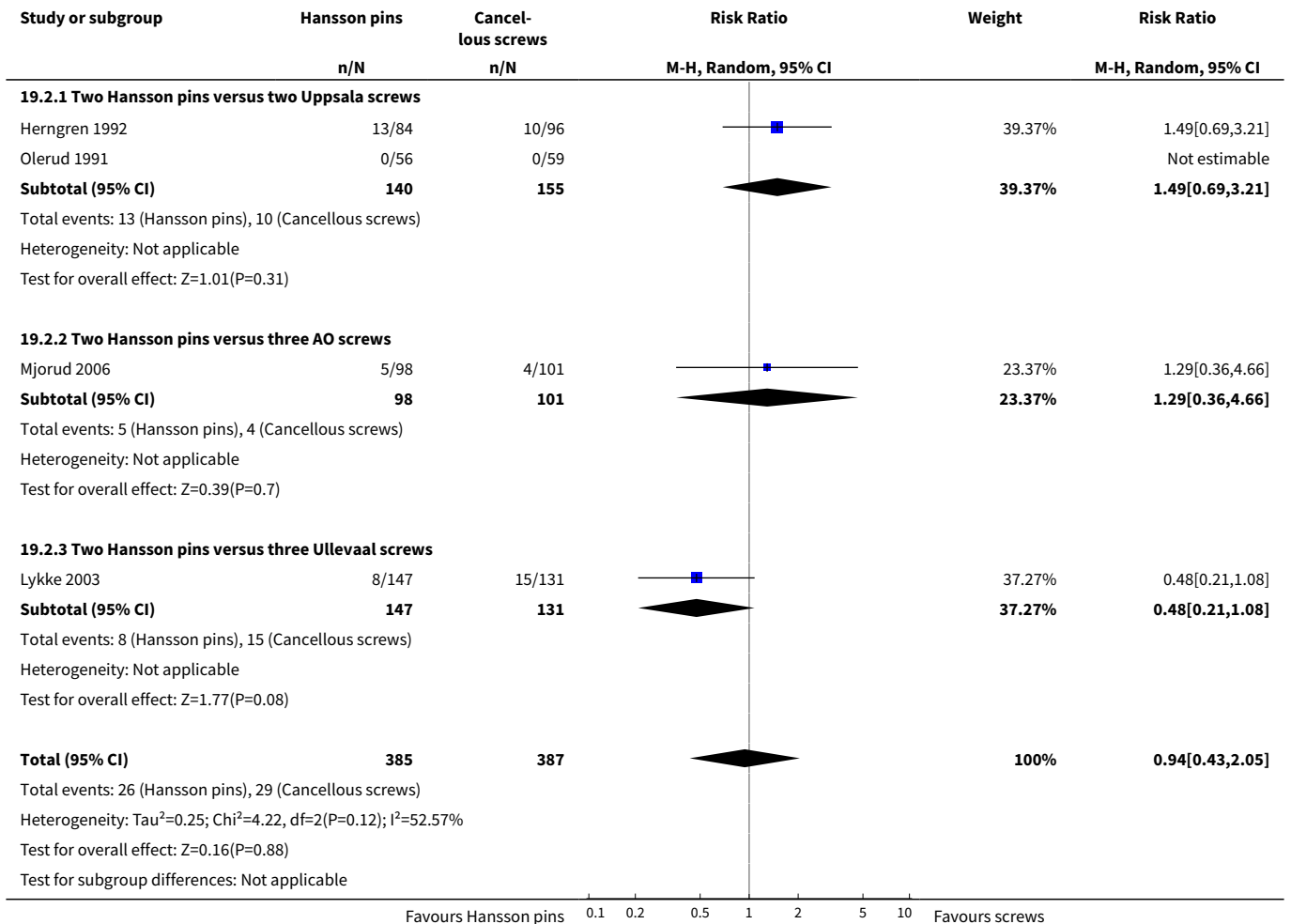
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8.1 Two Hansson pins versus two Uppsala screws	1	180	Risk Ratio (M-H, Fixed, 95% CI)	0.76 [0.13, 4.45]
8.2 Two Hansson pins versus three Ullevaal screws	1	278	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
9 Superficial wound infection	1	278	Risk Ratio (M-H, Fixed, 95% CI)	1.78 [0.16, 19.43]
9.1 Two Hansson pins versus three Ullevaal screws	1	278	Risk Ratio (M-H, Fixed, 95% CI)	1.78 [0.16, 19.43]
10 Mortality	5	882	Risk Ratio (M-H, Fixed, 95% CI)	0.85 [0.68, 1.06]
10.1 Two Hansson pins versus two Uppsala screws	2	295	Risk Ratio (M-H, Fixed, 95% CI)	0.63 [0.38, 1.04]
10.2 Two Hansson pins versus two cancellous AO	1	110	Risk Ratio (M-H, Fixed, 95% CI)	0.93 [0.29, 3.03]
10.3 Two Hansson pins versus three AO screws	1	199	Risk Ratio (M-H, Fixed, 95% CI)	0.87 [0.57, 1.33]
10.4 Two Hansson pins versus three Ullevaal screws	1	278	Risk Ratio (M-H, Fixed, 95% CI)	0.97 [0.70, 1.35]

Analysis 19.1. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 1 Non-union.

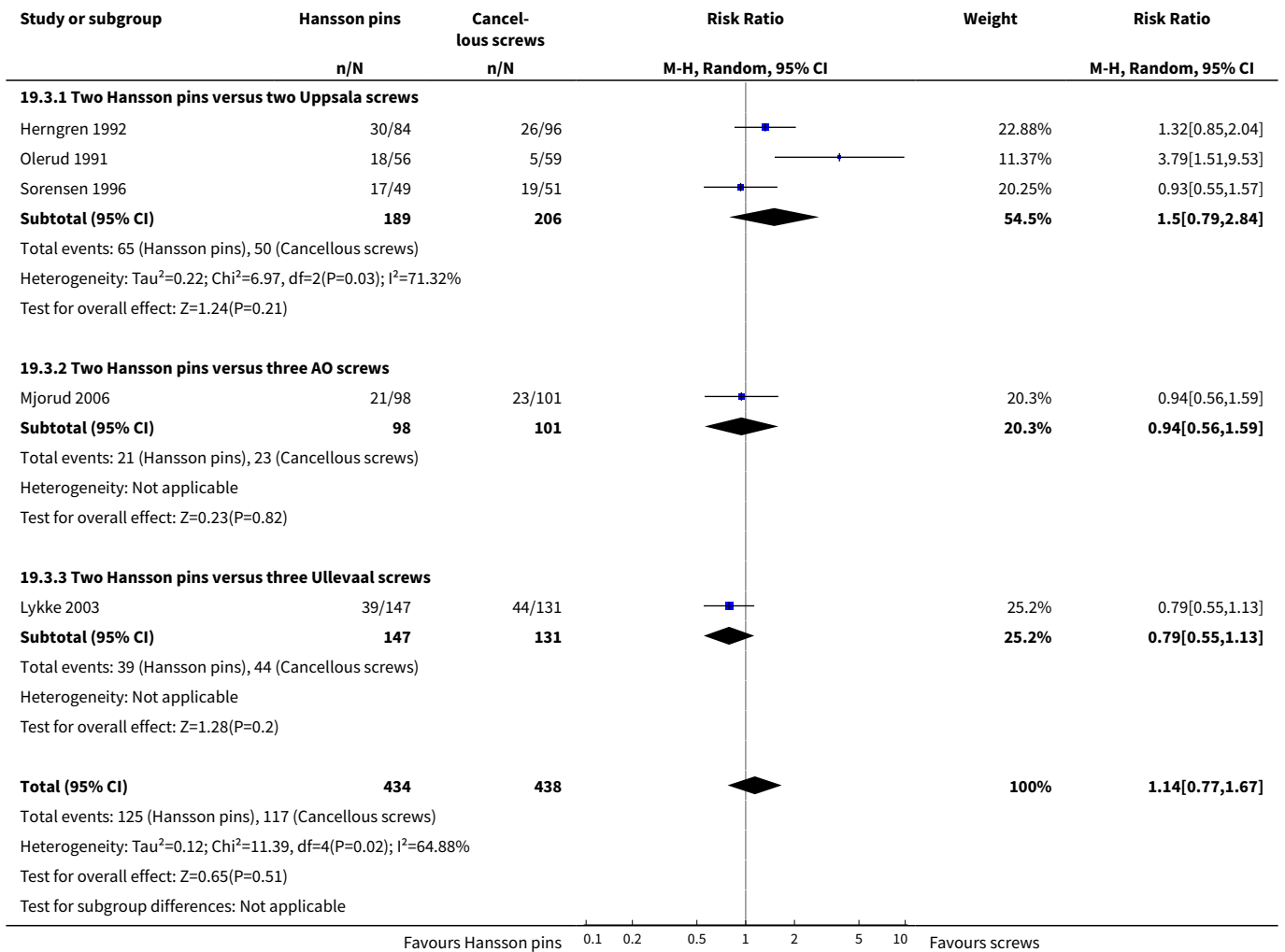




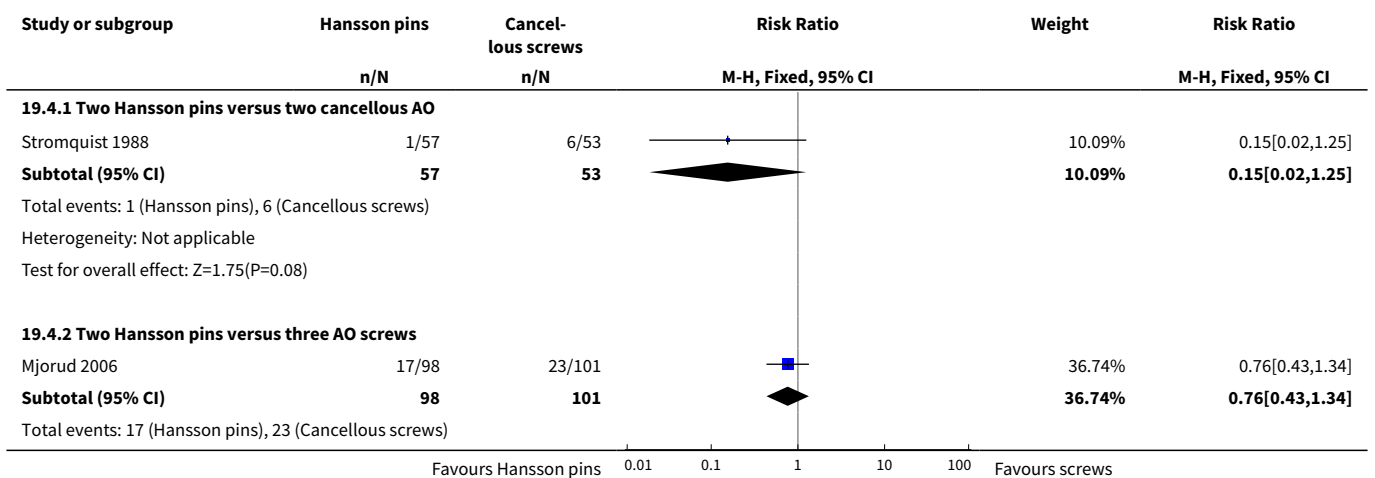
Analysis 19.2. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 2 Avascular necrosis.

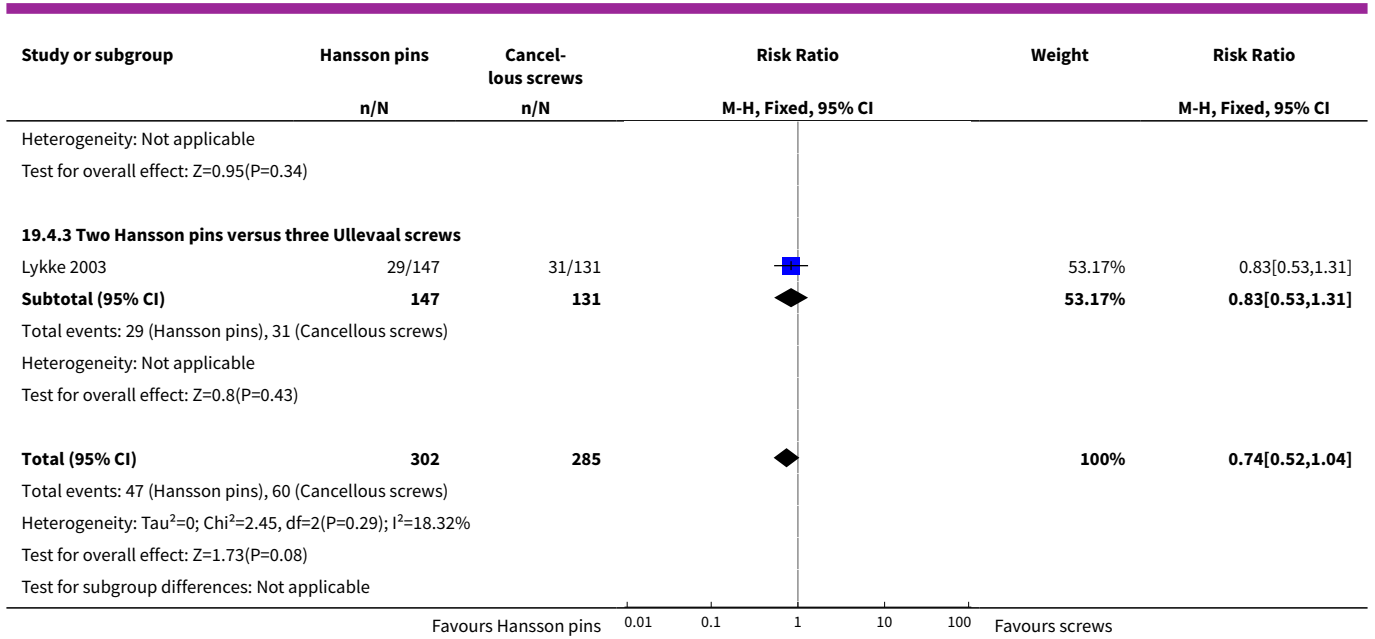


Analysis 19.3. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 3 All fracture healing complications.

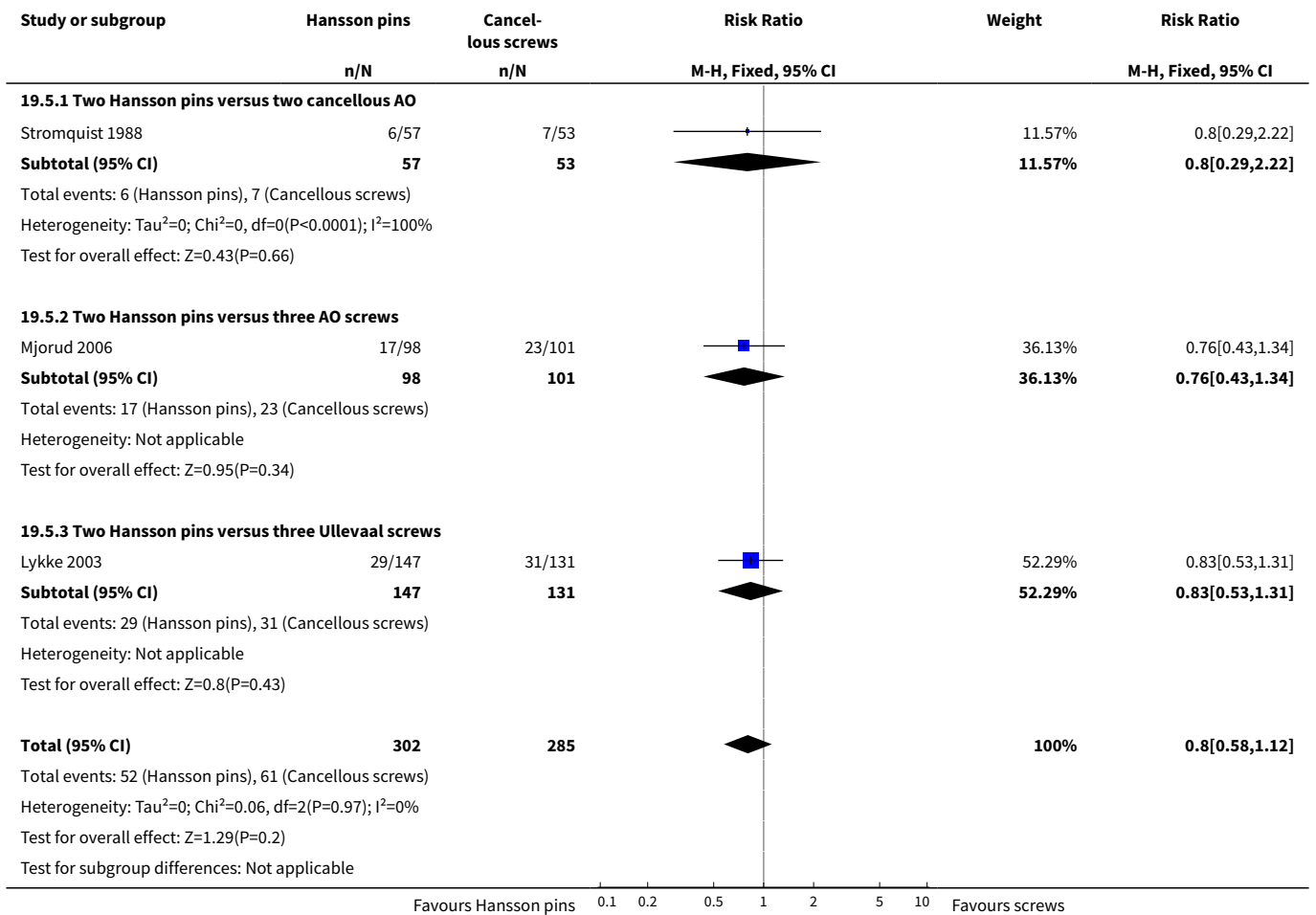


Analysis 19.4. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 4 Re-operations - arthroplasty.

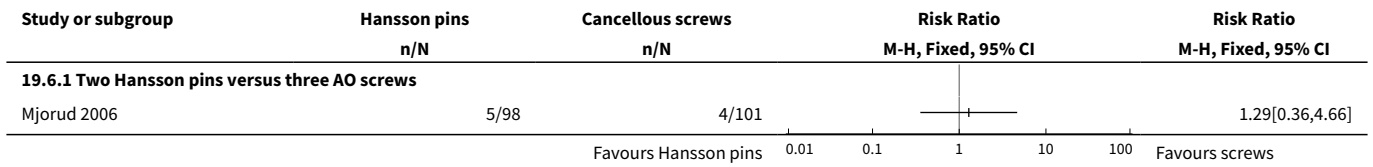




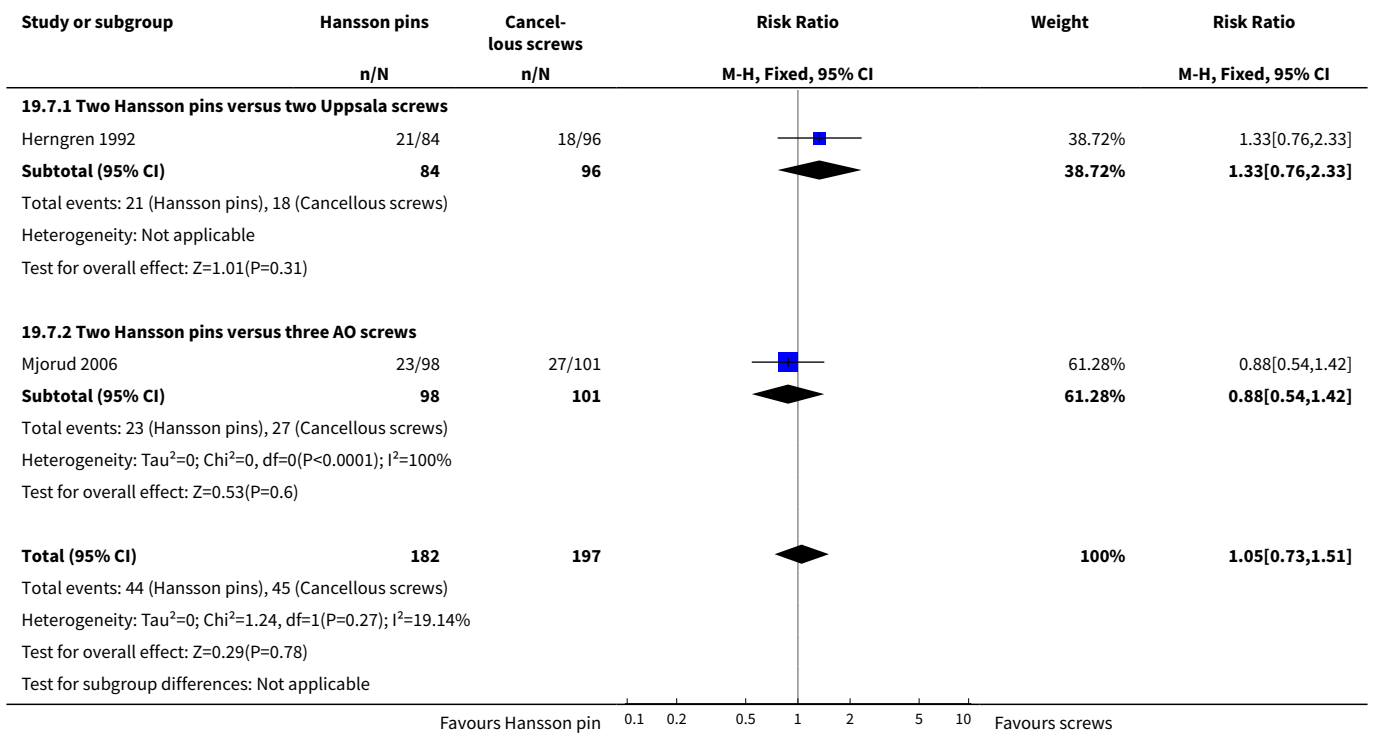
Analysis 19.5. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 5 Re-operation - arthroplasty or need for arthroplasty.



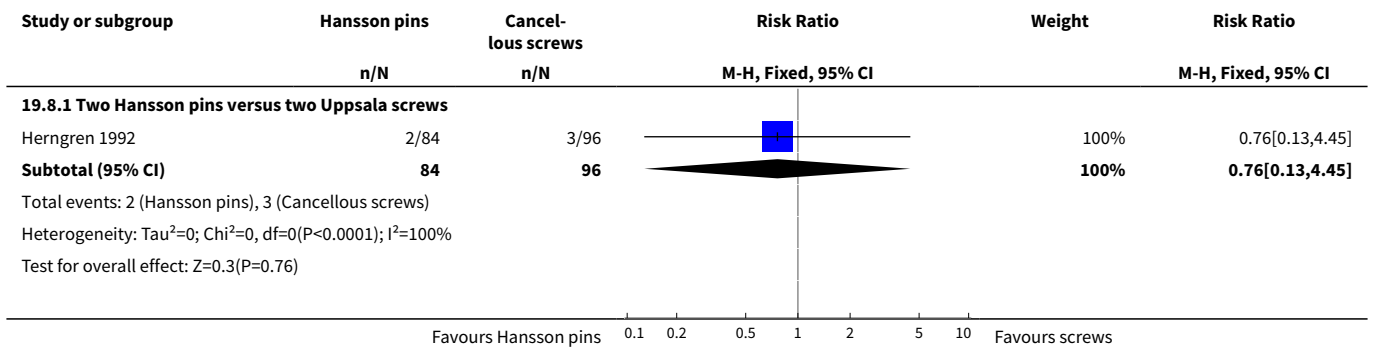
Analysis 19.6. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 6 Re-operations - implant removal.

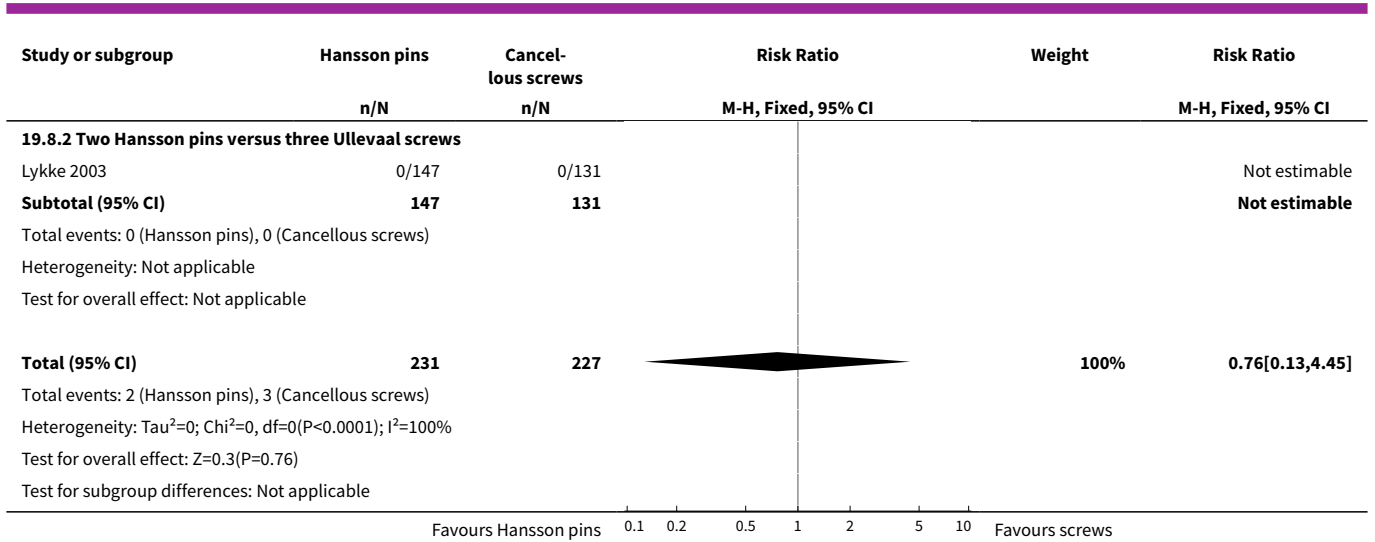


Analysis 19.7. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 7 Re-operations - type not specified.

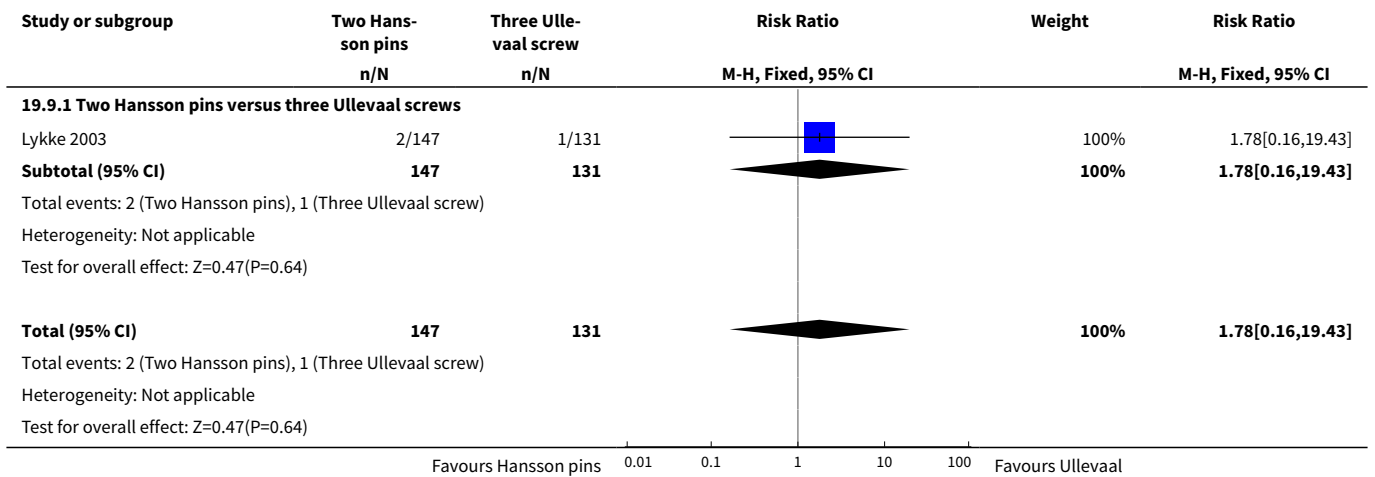


Analysis 19.8. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 8 Deep wound infection.

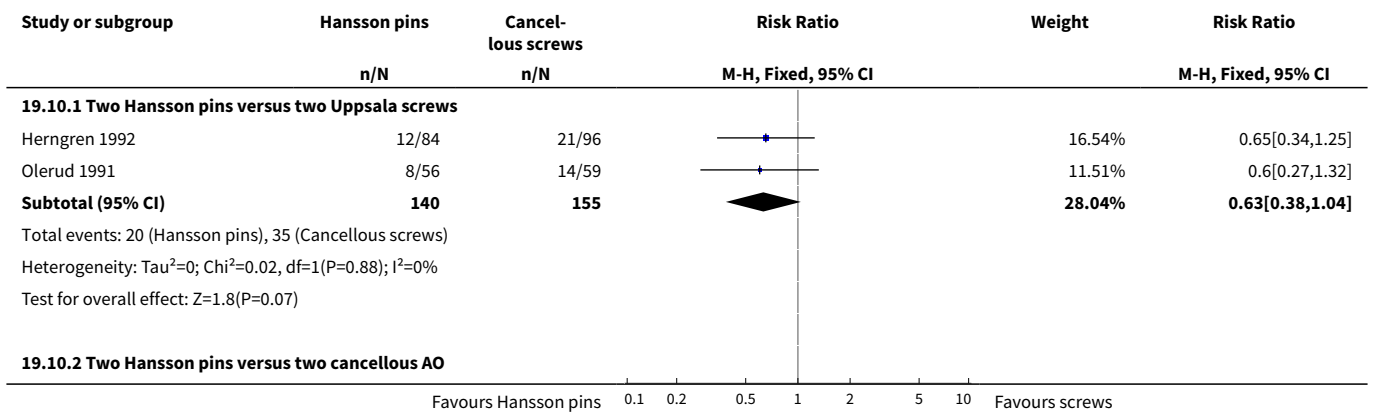


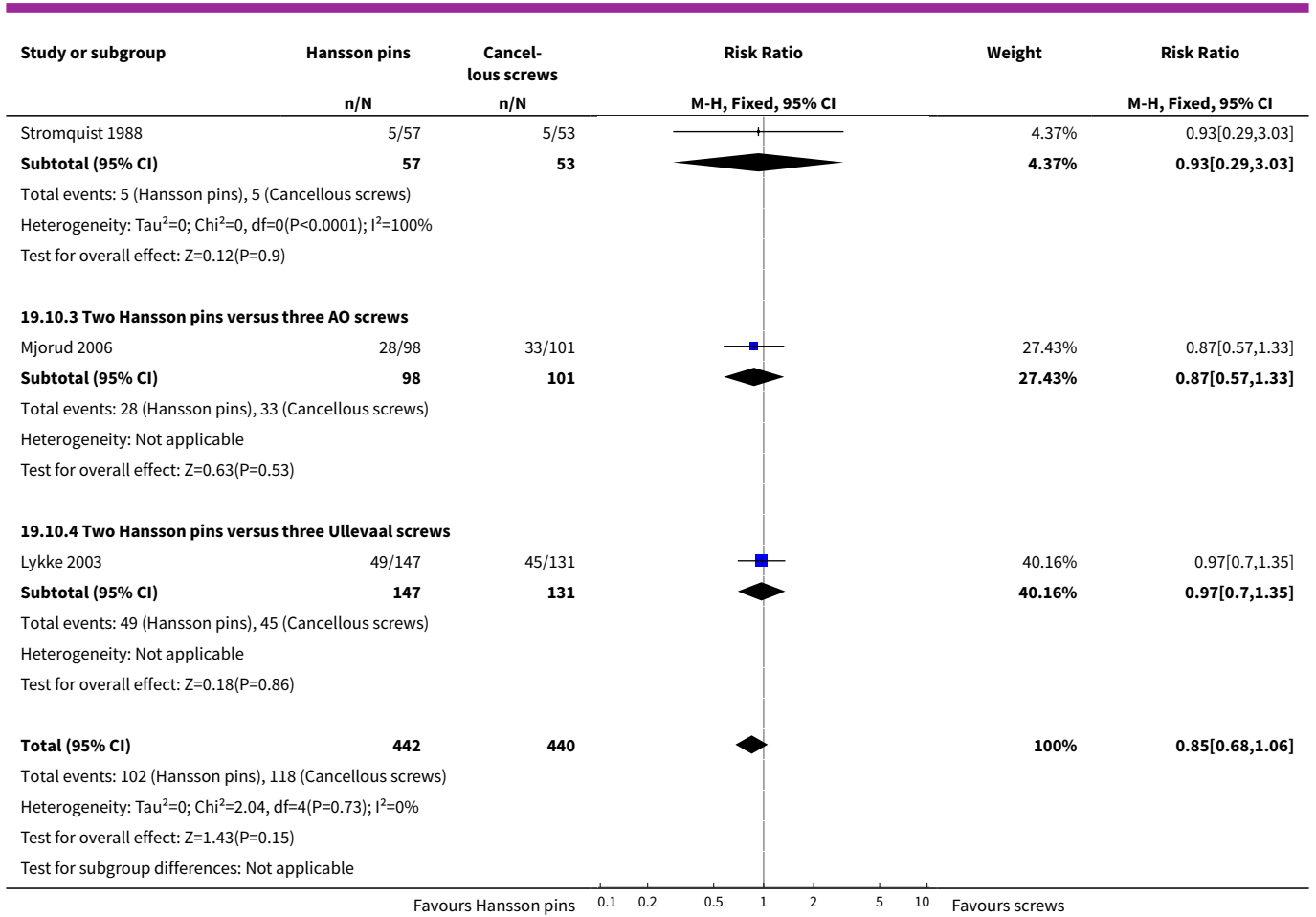


Analysis 19.9. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 9 Superficial wound infection.



Analysis 19.10. Comparison 19 Two Hansson pins versus cancellous screws, Outcome 10 Mortality.





ADDITIONAL TABLES

Table 1. Methodological quality assessment scheme

Items	Scores
1. Was there an adequate method of sequence generation?	Score 1 if adequate method such as table of random numbers, shuffled envelopes, coin tossing. Score 0 if inadequate such as date of birth, patient registration number.
2. Was there clear concealment of allocation?	Score 1 if adequate such as central allocation, sequentially numbered opaque envelopes drawn consecutively. Otherwise score 0.
3. Were the outcome assessors blind to assignment status?	Score 1 if assessors of pain and function at follow-up were blinded to treatment outcome. Otherwise score 0.
4. Were the inclusion and exclusion criteria clearly defined?	Score 1 if text states type of fracture and which patients were included and/or excluded. Otherwise score 0.
5. Were the outcomes of patients who withdrew or excluded after randomisation described and included in an intention-to-treat analysis?	Score 1 if yes or text states that no withdrawals occurred of patients after randomisation or if they were included separately and results included in the group to which they were allocated. Otherwise score 0.

Table 1. Methodological quality assessment scheme (Continued)

6. Were the treatment and control groups adequately described at entry and if so were the groups well matched, or appropriate covariate adjustment made?	Score 1 if at least four admission details given (e.g. age, sex, mobility, function score, mental test score, fracture type) with either no important difference between groups or appropriate adjustment made. Otherwise score 0.
7. Were less than 5% of patients lost to follow-up.	Score 1 if yes. Otherwise score 0.
8. Was the timing of outcome measures appropriate?	A minimum of 12 months follow-up for all surviving patients. Score 1 if yes. Otherwise score 0.
9. Were the outcome measures clearly defined in the text with a definition of any ambiguous terms encountered?	Score 1 if yes. Otherwise score 0.
10. Were the surgeons experienced at both operations prior to commencement of the trial?	Score 1 if text states there was an introductory period or that all surgeons were experienced in both operations. Otherwise score 0.
11. Were the care programmes other than trial options identical?	Score 1 if text states they were or if this can be inferred. Otherwise score 0.

APPENDICES

Appendix 1. Search strategies

Cochrane Central Register of Controlled Trials (Wiley Online Library)

- #1 MeSH descriptor Hip Fractures explode all trees (927)
- #2 ((hip* or femur* or femoral* or intracapsular* or subcapital or transcervical) NEAR/4 fracture*):ti,ab,kw (1952)
- #3 (#1 OR #2) (1952)
- #4 (pin or pins or pinned or pinning or nail* or screw* or plate* or arthroplast* or fix* or prosthes*):ti,ab,kw (29319)
- #5 MeSH descriptor Internal Fixators, this term only (98)
- #6 MeSH descriptor Bone Screws, this term only (394)
- #7 MeSH descriptor Fracture Fixation, Internal explode all trees (652)
- #8 MeSH descriptor Bone Plates, this term only (212)
- #9 MeSH descriptor Bone Nails, this term only (250)
- #10 MeSH descriptor Arthroplasty, this term only (139)
- #11 MeSH descriptor Arthroplasty, Replacement, Hip, this term only (1172)
- #12 (#4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11) (29319)
- #13 (#3 AND #12) (745)
- #14 (extracapsular or trochanteric or subtrochanteric or pertrochanteric or intertrochanteric):ti (389)
- #15 (intracapsular or subcapital or transcervical):ti (225)
- #16 (#14 AND NOT #15) (379)
- #17 (#13 AND NOT #16) (499)

MEDLINE (Ovid Web)

- 1 exp Hip Fractures/ (14794)
- 2 ((hip\$ or femur\$ or femoral\$ or intracapsular\$ or subcapital or transcervical) adj4 fracture\$).tw. (20570)
- 3 or/1-2 (24920)
- 4 (pin\$1 or nail\$ or screw\$1 or plate\$1 or arthroplast\$ or fix\$ or prosthes\$).tw. (385604)
- 5 Internal Fixators/ or Bone Screws/ or Fracture Fixation, Internal/ or Bone Plates/ or Bone Nails/ (40241)
- 6 Arthroplasty/ or Arthroplasty, Replacement, Hip/ (17548)
- 7 or/4-6 (404588)
- 8 and/3,7 (10370)
- 9 (extracapsular or trochanteric or subtrochanteric or pertrochanteric or intertrochanteric).ti. (3536)
- 10 (intracapsular or subcapital or transcervical).ti. (1753)
- 11 9 not 10 (3458)

Internal fixation implants for intracapsular hip fractures in adults (Review)

12 8 not 11 (9105)
13 Randomized Controlled Trial.pt. (298721)
14 Controlled Clinical Trial.pt. (82422)
15 randomized.ab. (205154)
16 placebo.ab. (121719)
17 Clinical Trials as Topic.sh. (150826)
18 randomly.ab. (149185)
19 trial.ti. (88477)
20 13 or 14 or 15 or 16 or 17 or 18 or 19 (692318)
21 exp Animals/ not Humans/ (3531211)
22 20 not 21 (640356)
23 12 and 22 (461)

EMBASE (Ovid Web)

1 exp Hip Fracture/ (20636)
2 ((hip\$ or femur\$ or femoral or intracapsular\$ or subcapital or transcervical) adj4 fracture\$.tw. (23792)
3 or/1-2 (31432)
4 (pin\$1 or nail\$ or screw\$1 or plate\$1 or arthroplast\$ or fix\$ or prosthesis\$.tw. (434374)
5 Bone Nail/ or Bone Plate/ or Bone Screw/ or Ender Nail/ or External Fixator/ or Fixation Device/ or Interlocking Nail/ or Internal Fixator/
or Osteosynthesis Material/ (26043)
6 exp Fracture Fixation/ (52878)
7 Arthroplasty/ or Hip Arthroplasty/ (18137)
8 or/4-7 (465804)
9 and/3,8 (13255)
10 (extracapsular or trochanteric or subtrochanteric or pertrochanteric or intertrochanteric).ti. (4058)
11 (intracapsular or subcapital or transcervical).ti. (1907)
12 10 not 11 (3967)
13 9 not 12 (11698)
14 Randomized Controlled Trial/ (280313)
15 Clinical Trial/ (804967)
16 Controlled Clinical Trial/ (161695)
17 Randomization/ (52313)
18 Single Blind Procedure/ (13269)
19 Double Blind Procedure/ (98937)
20 Prospective Study/ (154609)
21 ((clinical or controlled or comparative or prospective\$ or randomi#ed) adj3 (trial or study)).tw. (508940)
22 (random\$ adj7 (allocat\$ or allot\$ or assign\$ or basis\$ or divid\$ or order\$)).tw. (126704)
23 ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj7 (blind\$ or mask\$)).tw. (126329)
24 ((allocat\$ or allot\$ or assign\$ or divid\$) adj3 (condition\$ or experiment\$ or intervention\$ or treatment\$ or therap\$ or control\$ or group
\$)).tw. (150805)
25 RCT.tw. (5874)
26 or/14-25 (1373779)
27 Case Study/ or Abstract Report/ or Letter/ (762331)
28 26 not 27 (1345199)
29 13 and 28 (1397)

Appendix 2. Methodological quality assessment results

Study ID	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11
<i>Thornton nail versus three Scand pins</i>											
Dalen 1985	0	0	0	0	0	0	1	0	0	0	0
<i>Thornton nail versus sliding nail plate</i>											
Frandsen 1981	0	0	0	1	0	0	0	1	1	0	1
<i>Sliding compression screw plate versus McLaughlin nail plate</i>											
Svenningsen 1984	0	1	0	1	0	0	1	1	1	0	1
<i>Sliding hip screw versus sliding nail plate</i>											
Nordkild 1985	0	0	0	1	1	0	1	0	1	0	1
<i>Sliding hip screw versus double divergent pins</i>											
Christie 1988	0	0	0	1	1	0	0	1	1	0	1
<i>Sliding hip screw versus two von Bahr screws</i>											
Paus 1986	0	0	0	1	0	1	1	1	1	0	1
<i>Sliding hip screw versus Gouffon screws</i>											
Sorensen 1992	0	0	0	1	1	1	1	1	1	0	1
<i>Sliding hip screw versus cancellous screws</i>											
Harper 1992	0	0	0	1	0	1	0	1	0	1	1
Madsen 1987	0	0	0	1	0	0	0	1	1	0	1
Kuokkanen 1991	0	0	0	1	1	0	1	1	1	0	0
<i>Sliding hip screw versus Hansson pins versus Uppsala screws</i>											

(Continued)

Sorensen 1996	0	0	0	0	0	0	0	0	1	0	0	0
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Sliding hip screw versus two Uppsala or Olmed screws

Benterud 1997	0	0	0	1	1	0	0	1	0	0	0	0
---------------	---	---	---	---	---	---	---	---	---	---	---	---

Ovesen 1997	0	0	0	0	0	0	0	1	0	0	0	0
-------------	---	---	---	---	---	---	---	---	---	---	---	---

Sliding hip screw versus two Hansson pins

Elmerson 1995	1	0	0	1	1	0	1	1	1	1	0	1
---------------	---	---	---	---	---	---	---	---	---	---	---	---

Three Gouffon pins versus a Rydell four flanged nail

Elmerson 1988	1	0	0	1	0	0	1	1	1	1	0	1
---------------	---	---	---	---	---	---	---	---	---	---	---	---

Wihlborg 1990	0	0	0	0	1	0	1	1	1	1	1	1
---------------	---	---	---	---	---	---	---	---	---	---	---	---

Two Hansson pins versus a Rydell four flanged nail

Holmberg 1990	0	0	0	0	1	1	1	1	1	1	1	1
---------------	---	---	---	---	---	---	---	---	---	---	---	---

Sernbo 1990	1	0	0	1	1	1	1	1	1	1	0	0
-------------	---	---	---	---	---	---	---	---	---	---	---	---

Stromqvist 1984	0	0	0	1	1	0	1	1	1	1	0	1
-----------------	---	---	---	---	---	---	---	---	---	---	---	---

Two Hansson pins versus two Uppsala screws

Herngren 1992	1	0	0	1	1	0	1	1	1	1	1	1
---------------	---	---	---	---	---	---	---	---	---	---	---	---

Olerud 1991	0	0	0	0	0	0	1	1	1	1	0	1
-------------	---	---	---	---	---	---	---	---	---	---	---	---

Two Hansson hook pins versus three Ullevaal screws

Lykke 2003	0	1	0	1	0	1	0	1	1	1	1	0
------------	---	---	---	---	---	---	---	---	---	---	---	---

Two Hansson hook pins versus two AO screws

Stromquist 1988	0	0	0	0	0	0	0	1	0	1	0	0
-----------------	---	---	---	---	---	---	---	---	---	---	---	---

Two Hansson hook pins versus three AO screws

(Continued)

Mjorud 2006	0	0	1	1	0	1	0	1	1	0	1
Three Richard screws versus two Uppsala screws											
Lagerby 1998	0	0	0	1	1	1	0	1	1	0	1
Two von Bahr screws versus two Uppsala screws											
Rehnberg 1989	1	0	0	1	1	1	1	1	1	0	1
Three Ullevaal screws versus two Olmed screws											
Alho 1998(a)	1	0	0	1	1	1	1	1	0	0	1
Three Ullevaal screws versus two Tronzo screws											
Alho 1998(b)	1	0	0	1	1	1	1	1	0	0	1
Three Ullevaal screws versus two Olmed screws											
Alho 1998(c)	1	0	0	1	1	1	1	1	0	0	1
Three Nystrom nails versus three Scand screws											
Alberts 1989	0	0	0	1	1	0	1	1	1	0	0
von Bahr screws versus Hessel pins versus Gouffon screws											
Lindequist 1989	0	0	0	0	0	1	1	1	1	0	1
Three short thread AO screws versus three long threaded AO screws											
Parker 2010	1	0	0	1	1	1	1	1	1	1	1

WHAT'S NEW

Date	Event	Description
18 January 2011	New search has been performed	<p>For this update, published in Issue 2, 2011, the following amendments were made:</p> <ol style="list-style-type: none"> 1. Title changed from 'Internal fixation implants for intracapsular proximal femoral fractures in adults' to 'Internal fixation implants for intracapsular hip fractures in adults' 2. New studies of Mjorud 2006 and Parker 2010 included. 3. Ongoing study of FAITH added. 4. Risk of bias assessment implemented for sequence generation and allocation concealment. 5. Additional reference to studies of Stromqvist 1984 and Sernbo 1990 added. <p>There were no changes to the conclusions of the review.</p>

HISTORY

Protocol first published: Issue 2, 1999

Review first published: Issue 4, 2001

Date	Event	Description
27 June 2008	Amended	Converted to new review format.
27 August 2003	New search has been performed	<p>For the first update in Issue 4, 2003 the following changes were made:</p> <ol style="list-style-type: none"> 1. New study of Lykke 2003 included. 2. Sernbo 1986 and Jukkala-Partio 2000 added to excluded studies. 3. Extra reference to studies of Olerud 1991 and Sorensen 1992 added. <p>There were no changes to the conclusions of the review.</p>

CONTRIBUTIONS OF AUTHORS

Martyn Parker initiated and designed the review, read all studies, extracted data and compiled the first drafts. Kurinchi Gurusamy checked data from the newly studies identified for the first and second update. Martyn Parker is the guarantor of the review.

DECLARATIONS OF INTEREST

Martyn Parker was the lead author of one of the studies included in this review ([Parker 2010](#)). The assessment of this study was undertaken by Kurinchi Gurusamy and Helen Handoll. Martyn Parker has received and may continue to receive financial payment from manufacturing companies of orthopaedic implants used for the internal fixation of hip fractures and for attending meeting organised by these companies and for advising on the design and use of hip fracture implants. Kurinchi Gurusamy has no connection with any manufacturing company.

SOURCES OF SUPPORT

Internal sources

- Scottish Home and Health Department, UK.

External sources

- No sources of support supplied

Internal fixation implants for intracapsular hip fractures in adults (Review)

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

In the update of the review (2011), two aspects of risk of bias were assessed and reported: sequence generation and allocation concealment. We also modified our former scheme for assessment methodological quality, mainly adding in an item for sequence generation.

INDEX TERMS

Medical Subject Headings (MeSH)

*Bone Nails; *Bone Screws; Fracture Fixation, Internal [*instrumentation] [methods]; Hip Fractures [*surgery]; Randomized Controlled Trials as Topic

MeSH check words

Humans