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Surgical interventions for treating intracapsular hip fractures in older adults: a network meta-analysis (Review)

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[Intervention Review]

Surgical interventions for treating intracapsular hip fractures in older adults: a network meta-analysis

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ABSTRACT

Background

Hip fractures are a major healthcare problem, presenting a considerable challenge and burden to individuals and healthcare systems. The number of hip fractures globally is rising rapidly. The majority of intracapsular hip fractures are treated surgically.

Objectives

To assess the relative effects (benefits and harms) of all surgical treatments used in the management of intracapsular hip fractures in older adults, using a network meta-analysis of randomised trials, and to generate a hierarchy of interventions according to their outcomes.

Search methods

We searched CENTRAL, MEDLINE, Embase, Web of Science, and five other databases in July 2020. We also searched clinical trials databases, conference proceedings, reference lists of retrieved articles and conducted backward-citation searches.

Selection criteria

We included randomised controlled trials (RCTs) and quasi-RCTs comparing different treatments for fragility intracapsular hip fractures in older adults. We included total hip arthroplasties (THAs), hemiarthroplasties (HAs), internal fixation, and non-operative treatments. We excluded studies of people with hip fracture with specific pathologies other than osteoporosis or resulting from high-energy trauma.

Data collection and analysis

Two review authors independently assessed studies for inclusion. One review author completed data extraction which was checked by a second review author. We collected data for three outcomes at different time points: mortality and health-related quality of life (HRQoL) - both reported within 4 months, at 12 months, and after 24 months of surgery, and unplanned return to theatre (at end of study follow-up).

We performed a network meta-analysis (NMA) with Stata software, using frequentist methods, and calculated the differences between treatments using risk ratios (RRs) and standardised mean differences (SMDs) and their corresponding 95% confidence intervals (CIs). We also performed direct comparisons using the same codes.

Main results

We included 119 studies (102 RCTS, 17 quasi-RCTs) with 17,653 participants with 17,669 intracapsular fractures in the review; 83% of fractures were displaced. The mean participant age ranged from 60 to 87 years and 73% were women.

After discussion with clinical experts, we selected 12 nodes that represented the best balance between clinical plausibility and efficiency of the networks: cemented modern unipolar HA, dynamic fixed angle plate, uncemented first-generation bipolar HA, uncemented modern bipolar HA, cemented modern bipolar HA, uncemented first-generation unipolar HA, uncemented modern unipolar HA, THA with single articulation, dual-mobility THA, pins, screws, and non-operative treatment. Seventy-five studies (with 11,855 participants) with data for at least two of these treatments contributed to the NMA.

We selected cemented modern unipolar HA as a reference treatment against which other treatments were compared. This was a common treatment in the networks, providing a clinically appropriate comparison. In order to provide a concise summary of the results, we report only network estimates when there was evidence of difference between treatments.

We downgraded the certainty of the evidence for serious and very serious risks of bias and when estimates included possible transitivity, particularly for internal fixation which included more undisplaced fractures. We also downgraded for incoherence, or inconsistency in indirect estimates, although this affected few estimates. Most estimates included the possibility of benefits and harms, and we downgraded the evidence for these treatments for imprecision.

We found that cemented modern unipolar HA, dynamic fixed angle plate and pins seemed to have the greatest likelihood of reducing mortality at 12 months. Overall, 23.5% of participants who received the reference treatment died within 12 months of surgery. Uncemented modern bipolar HA had higher mortality than the reference treatment (RR 1.37, 95% CI 1.02 to 1.85; derived only from indirect evidence; low-certainty evidence), and THA with single articulation also had higher mortality (network estimate RR 1.62, 95% CI 1.13 to 2.32; derived from direct evidence from 2 studies with 225 participants, and indirect evidence; very low-certainty evidence). In the remaining treatments, the certainty of the evidence ranged from low to very low, and we noted no evidence of any differences in mortality at 12 months.

We found that THA (single articulation), cemented modern bipolar HA and uncemented modern bipolar HA seemed to have the greatest likelihood of improving HRQoL at 12 months. This network was comparatively sparse compared to other outcomes and the certainty of the evidence of differences between treatments was very low. We noted no evidence of any differences in HRQoL at 12 months, although estimates were imprecise.

We found that arthroplasty treatments seemed to have a greater likelihood of reducing unplanned return to theatre than internal fixation and non-operative treatment. We estimated that 4.3% of participants who received the reference treatment returned to theatre during the study follow-up. Compared to this treatment, we found low-certainty evidence that more participants returned to theatre if they were treated with a dynamic fixed angle plate (network estimate RR 4.63, 95% CI 2.94 to 7.30; from direct evidence from 1 study with 190 participants, and indirect evidence). We found very low-certainty evidence that more participants returned to theatre when treated with pins (RR 4.16, 95% CI 2.53 to 6.84; only from indirect evidence), screws (network estimate RR 5.04, 95% CI 3.25 to 7.82; from direct evidence from 2 studies with 278 participants, and indirect evidence), and non-operative treatment (RR 5.41, 95% CI 1.80 to 16.26; only from indirect evidence). There was very low-certainty evidence of a tendency for an increased risk of unplanned return to theatre for all of the arthroplasty treatments, and in particular for THA, compared with cemented modern unipolar HA, with little evidence to suggest the size of this difference varied strongly between the arthroplasty treatments.

Authors' conclusions

There was considerable variability in the ranking of each treatment such that there was no one outstanding, or subset of outstanding, superior treatments. However, cemented modern arthroplasties tended to more often yield better outcomes than alternative treatments and may be a more successful approach than internal fixation. There is no evidence of a difference between THA (single articulation) and cemented modern unipolar HA in the outcomes measured in this review. THA may be an appropriate treatment for a subset of people with intracapsular fracture but we have not explored this further.

PLAIN LANGUAGE SUMMARY

Which are the best treatments for hip fractures in older adults?

Why is this question important?

A hip fracture is a break at the top of the leg bone. We included people with a break just below the ball and socket joint. These types of broken hip are common in older adults whose bones may be fragile because of a condition called osteoporosis. They often happen after a fall from a standing or sitting position. The broken hip can be treated in different ways, and we don't know whether some treatments are better than others.

What are the treatments?

- Replacing the broken hip with an artificial one. This can be done using a hemiarthroplasty (HA), which replaces only the ball part of the joint, and can be unipolar (a single artificial joint) or bipolar which has an additional joint within the HA. A total hip arthroplasty (THA) replaces all of the hip joint, including the socket, and usually has just one artifical joint between the ball and the socket (single articulation) or sometimes two (dual-mobility). All types of artificial joints can be fixed in place with or without bone cement.

- Using metal implants to fix the broken parts of the bones. Pins or screws may be inserted through the two parts of broken bone, or the surgeon may use a 'fixed angle plate' which sits on the outer edge of the broken bone and is attached to the bone with screws or pins.

- Treatment without an operation, usually requiring a period of rest in bed whilst the leg is held in position using traction with weights.

What did we do?

We searched for studies that compared one or more of these treatments. We wanted to find out the benefits and harms of these different treatments. We combined the findings from studies, and created a 'network' (which is used when researchers perform a 'network meta-analysis' on the results from studies) to see if we could find out if some treatments were better than others.

What did we find?

We found 119 studies, involving 17,653 participants with 17,669 fractures. The average age of study participants ranged from 60 to 87 years; 73% were women, which is usual for people who have this type of hip fracture. We included 75 of these studies in our 'network'.

We found that a modern design of unipolar HA fixed with bone cement, or some of the metal implants (fixed angle plates and pins), seem to have the greatest chance of reducing the number of deaths within 12 months of injury. Compared to people having these treatments, more people who were treated with an uncemented modern bipolar design of HA or with a THA (single articulation) died.

We didn't find as many studies to include in our 'network' for health-related quality of life, and none of the treatments made a meaningful improvement to people's quality of life.

We also found that people treated with any of the hip replacements were less likely to need additional surgery on their broken hip than people treated with metal implants or treated without an operation. Amongst all the designs of hip replacements, fewer people needed additional surgery after treatment with a cemented modern unipolar design of HA - but there was not a big difference in the findings for these hip replacement treatments.

So, overall, cemented modern hip replacements tended to produce better outcomes and may be a more successful approach than attempting to fix the broken bone. THA (single articulation) may have increased the risk of death compared with cemented HA, without leading to an important difference in quality of life - but we are not sure about this finding. This type of THA may be an appropriate treatment for some people with these fractures, but we have not studied this in this review.

Are we confident in what we found?

The true effects of these treatments might be very different to what we have found in this review. Many of the studies in this review were published before general reporting standards for research were improved, and so we could not be certain whether or not these studies were well-conducted. Sometimes, the types of fractures were different (particularly between participants treated with metal implants and those treated with hip replacements), and this might have affected the results in the 'network'. We also found that the results included risks of potential benefits and harms, and this is often because there are not enough study participants to find a precise result.

How up to date is this review?

We ran our search in July 2020.

SUMMARY OF FINDINGS

Summary of findings 1. Certainty of the effects and network estimates of surgical interventions for treating intracapsular hip fractures in older adults: mortality at 12 months

Certainty of the effects and network estimates of surgical interventions for treating intracapsular hip fractures in older adults: mortality at 12 months

Population: older adults (> 60 years of age) with intracapsular hip fractures; most fractures in the included studies were displaced

Intervention: dynamic fixed angle plate; uncemented first-generation bipolar hemiarthroplasty; uncemented modern bipolar hemiarthroplasty; cemented modern bipolar hemiarthroplasty; uncemented first-generation unipolar hemiarthroplasty; uncemented modern unipolar hemiarthroplasty; total hip arthroplasty; dual-mobility total hip arthroplasty; pins; screws; non-operative treatment

Comparison: cemented modern unipolar hemiarthroplasty

Outcome: mortality (at 12 months): range of follow-up time points from four months up to 24 months after surgery

Setting: in hospital

Total studies: 56 **Total participants: 9419**	**Relative effect (95% CI)**	**Anticipated absolute effect* (95% CI)**			**Certainty of the evidence**
		Without intervention	**With intervention**	**Difference**	
Dynamic fixed angle plate (2 RCTs; 246 participants)[a]	**RR 1.02** (0.79 to 1.32)	235 per 1000	240 per 1000	5 more per 1000 (50 fewer to 76 more)	**Very low** Downgraded for risk of bias[b,c], intransitivity[d] and imprecision[e]
Uncemented first-generation bipolar hemiarthroplasty (No direct evidence, indirect evidence only)	**RR 1.42** (0.82 to 2.45)	235 per 1000	333 per 1000	98 more per 1000 (42 fewer to 340 more)	**Low** Downgraded for risk of bias[b,c] and imprecision[e]
Uncemented modern bipolar hemiarthroplasty (No direct evidence, indirect evidence only)	**RR 1.37** (1.02 to 1.85)	235 per 1000	323 per 1000	88 more per 1000 (5 more to 200 more)	**Low** Downgraded for risk of bias[b,c]
Cemented modern bipolar hemiarthroplasty (6 RCTs; 771 participants)[a]	**RR 1.14** (0.92 to 1.42)	235 per 1000	268 per 1000	33 more per 1000 (20 fewer to 99 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]

Uncemented first-generation unipolar hemiarthroplasty (4 RCTs; 668 participants)[a]	**RR 1.06** (0.86 to 1.30)	235 per 1000	249 per 1000	14 more per 1000 (32 fewer to 70 more)	**Low** Downgraded for risk of bias[b] and imprecision[e]
Uncemented modern unipolar hemiarthroplasty (4 RCTs; 891 participants)[a]	**RR 1.16** (0.93 to 1.45)	235 per 1000	273 per 1000	38 more per 1000 (16 fewer to 105 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]
Total hip arthroplasty (single articulation) (2 RCTs; 225 participants)[a]	**RR 1.62** (1.13 to 2.32)	235 per 1000	381 per 1000	146 more per 1000 (31 more to 310 more)	**Very low** Downgraded for risk of bias[b,c]
Dual-mobility total hip arthroplasty (No direct evidence, indirect evidence only)	**RR 1.07** (0.37 to 3.14)	235 per 1000	252 per 1000	17 more per 1000 (149 fewer to 504 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]
Pins (No direct evidence, indirect evidence only)	**RR 1.03** (0.78 to 1.37)	235 per 1000	243 per 1000	8 more per 1000 (52 fewer to 87 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]
Screws (3 RCTs; 152 participants)[a]	**RR 1.09** (0.90 to 1.33)	235 per 1000	257 per 1000	22 more per 1000 (23 fewer to 77 more)	**Very low** Downgraded for risk of bias[b,c], intransitivity[d] and imprecision[e]
Non-operative treatment (No direct evidence, indirect evidence only)	**RR 1.10** (0.59 to 2.07)	235 per 1000	260 per 1000	25 more per 1000 (96 fewer to 251 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]
Cemented modern unipolar hemiarthroplasty	Reference comparator	-	-	-	Reference comparator

*Anticipated absolute effects compare two risks by calculating the difference between the risk with the intervention group and the risk with the comparison/control group (reference comparator).
CI: confidence interval; **NMA:** network meta-analysis; **RR:** risk ratio

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

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

[a]Network estimate derived from direct evidence and indirect evidence (number of studies and participants is for direct evidence contributing to the network estimate)
[b]Risk of bias: all studies in direct and indirect estimates had unclear risks of bias in at least one domain (downgraded by one level)
[c]Risk of bias: studies in direct or indirect estimates (or both), had high risks of selection bias or 'other bias' (downgraded by one level)
[d]Intransitivity: indirect estimates included variation in numbers of displaced fractures and intransitivity may be evident (downgraded by one level)
[e]Imprecision: confidence interval in the network estimate included benefits as well as harms (downgraded by one level)
[f]Inconsistency: evidence of statistical inconsistency in direct and/or indirect estimates (downgraded by one level)

Summary of findings 2. Certainty of the effects and network estimates of surgical interventions for treating intracapsular hip fractures in older adults: health-related quality of life at 12 months

Certainty of the effects and network estimates of surgical interventions for treating intracapsular hip fractures in older adults: health-related quality of life at 12 months

Population: older adults (> 60 years of age) with intracapsular hip fractures; most fractures in the included studies were displaced

Intervention: dynamic fixed angle plates, uncemented modern bipolar hemiarthroplasty, cemented modern bipolar hemiarthroplasty, uncemented modern unipolar hemiarthroplasty, total hip arthroplasty (single articulation), screws, non-operative treatment

Comparison: cemented modern unipolar hemiarthroplasty

Outcome: HRQoL at 12 months: measured in most studies using EQ-5D, and in two studies using SF-12

Setting: in hospital

Total studies: 13 **Total participants: 2744**	**Anticipated absolute effect (95% CI)**			**Certainty of the evidence**	**Comment**
	Without intervention*	**With intervention**	**Difference**		
Dynamic fixed angle plate (No direct evidence, indirect evidence only)	The mean EQ-5D was 0.6	-	**SMD -0.45** (-0.95 to 0.06)	**Very low** Downgraded for risk of bias[b,c], intransitivity[d] and imprecision[e]	We did not find any statistically significant differences, though clinically important harms cannot be ruled out (MD -0.12, 95% CI -0.26 to 0.02)[f]
Uncemented modern bipolar hemiarthroplasty (No direct evidence, indirect evidence only)	The mean EQ-5D was 0.6	-	**SMD 0.09** (-0.39 to 0.57)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]	We did not find any statistically significant differences, though clinically important difference cannot be ruled out (MD 0.02, 95% CI -0.11 to 0.15)[f]

Cemented modern bipolar hemiarthroplasty (1 RCT; 120 participants)[a]	The mean EQ-5D was 0.6	-	**SMD 0.11** (-0.23 to 0.46)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]	We did not find any statistically significant differences, though clinically important difference cannot be ruled out (MD 0.03, 95% CI -0.06 to 0.12)[f]
Uncemented modern unipolar hemiarthroplasty (1 RCT; 201 participants)[a]	The mean EQ-5D was 0.6	-	**SMD -0.35** (-0.86 to 0.15)	**Very low** Downgraded for risk of bias[b,c], imprecision[e] and incoherence[g]	We did not find any statistically significant differences, though clinically important harms cannot be ruled out (MD -0.10, 95% CI -0.23 to 0.04)[f]
Total hip arthroplasty (single articulation) (1 RCT; 120 participants)[a]	The mean EQ-5D was 0.6	-	**SMD 0.15** (-0.20 to 0.50)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]	We did not find any statistically significant differences, though clinically important benefits cannot be ruled out (MD 0.04, 95% CI -0.05 to 0.13)[f]
Screws (1 RCT; 60 participants)[a]	The mean EQ-5D was 0.6	-	**SMD -0.20** (-0.58 to 0.19))	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]	We did not find any statistically significant differences, though clinically important harms cannot be ruled out (MD -0.05, 95% CI -0.16 to 0.05)[f]
Non-operative treatment (No direct evidence, indirect evidence only)	The mean EQ-5D was 0.6	-	**SMD -0.15** (-0.75 to 0.45)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]	We did not find any statistically significant differences, though clinically important difference cannot be ruled out (MD -0.04, 95% CI -0.20 to 0.12)[f]
Cemented modern unipolar hemiarthroplasty	Reference comparator	-	Reference comparator	-	-

*Anticipated absolute effects without intervention is median value observed for the mean in the reference comparator groups across trials reporting the EQ-5D.
CI: confidence interval; **EQ-5D:** EuroQol-5 dimensions;**MD**: mean difference; **NMA:** network meta-analysis; **SF-12:** Short form 12; **SMD:** standardised mean difference

GRADE Working Group grades of evidence
High certainty: we are confident that the true estimate lies close to the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate. The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate. The true effect is likely to be substantially different from the estimate of the effect

[a]Network estimate derived from direct evidence and indirect evidence (number of studies and participants is for direct evidence contributing to the network estimate)

[b]Risk of bias: all studies in direct and indirect estimates had unclear risks of bias in at least one domain (downgraded by one level)
[c]Risk of bias: studies in direct or indirect estimates (or both) had high risks of selection bias, attrition bias or 'other bias' (downgraded by one level)
[d]Intransitivity: indirect estimates included variation in numbers of displaced fractures and intransitivity may be evident (downgraded by one level)
[e]Imprecision: confidence interval in the network estimate included benefits as well as harms (downgraded by one level)
[f]MD is presented on an EQ-5D scale using median SD from studies which reported the EQ-5D for the reference comparator group. Assessments were made of clinical importance against thresholds in the range of 0.05 to 0.08
[g]Incoherence: incoherence between direct and indirect estimate from network side-split investigation (downgraded by one level)

Summary of findings 3. Certainty of the effects and network estimates of surgical interventions for treating intracapsular hip fractures in older adults: unplanned return to theatre

Certainty of the effects and network estimates of surgical interventions for treating intracapsular hip fractures in older adults: unplanned return to theatre

Population: older adults (> 60 years of age) with intracapsular hip fractures; most fractures in the included studies were displaced

Intervention: dynamic fixed angle plate; uncemented first-generation bipolar hemiarthroplasty; uncemented modern bipolar hemiarthroplasty; cemented modern bipolar hemiarthroplasty; uncemented first-generation unipolar hemiarthroplasty; uncemented modern unipolar hemiarthroplasty; total hip arthroplasty; dual-mobility total hip arthroplasty; pins; screws; non-operative treatment

Comparison: cemented modern unipolar hemiarthroplasty

Outcome: unplanned return to theatre: at the end of study follow-up (range from 4 months to 17 years, but follow-up in most studies was at 12 to 36 months. Only one study reported follow-up at 17 years)

Setting: in hospital

Total studies: 53 **Total participants: 9493**	**Relative effect (95% CI)**	**Anticipated absolute effect* (95% CI)**			**Certainty of the evidence**
		Without intervention	**With intervention**	**Difference**	
Dynamic fixed angle plate (1 RCT; 190 participants)[a]	**RR 4.63** (2.94 to 7.30)	43 per 1000	199 per 1000	156 more per 1000 (83 more to 271 more)	**Low** Downgraded for risk of bias[b,c]
Uncemented first-generation bipolar hemiarthroplasty (No direct evidence, indirect evidence only)	**RR 1.36** (0.10 to 17.63)	43 per 1000	58 per 1000	15 more per 1000 (39 fewer to 715 more)	**Very low** Downgraded for risk of bias[b,c], intransitivity[d] and imprecision[e]
Uncemented modern bipolar hemiarthroplasty	**RR 1.92** (0.75 to 4.95)	43 per 1000	83 per 1000	40 more per 1000 (11 fewer to 170 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]

(No direct evidence, indirect evidence only)					
Cemented modern bipolar hemiarthroplasty (3 RCTs; 485 participants)[a]	**RR 1.40** (0.84 to 2.35)	43 per 1000	60 per 1000	17 more per 1000 (7 fewer to 58 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]
Uncemented first-generation unipolar hemiarthroplasty (1 RCT; 400 participants)[a]	**RR 1.43** (0.85 to 2.40)	43 per 1000	61 per 1000	18 more per 1000 (7 fewer to 60 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]
Uncemented modern unipolar hemiarthroplasty (3 RCTs; 491 participants)[a]	**RR 1.83** (0.52 to 6.41)	43 per 1000	79 per 1000	36 more per 1000 (21 fewer to 233 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]
Total hip arthroplasty (single articulation) (3 RCTs; 306 participants)[a]	**RR 1.45** (0.87 to 2.42)	43 per 1000	62 per 1000	19 more per 1000 (6 fewer to 61 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]
Dual-mobility total hip arthroplasty (No direct evidence, indirect evidence only)	**RR 0.64** (0.02 to 17.67)	43 per 1000	28 per 1000	15 fewer per 1000 (42 fewer to 717 more)	**Very low** Downgraded for risk of bias[b,c] and imprecision[e]
Pins (No direct evidence, indirect evidence only)	**RR 4.16** (2.53 to 6.84)	43 per 1000	179 per 1000	136 more per 1000 (66 more to 251 more)	**Very low** Downgraded for risk of bias[b,c] and intransitivity[d]
Screws (2 RCTs; 278 participants)[a]	**RR 5.04** (3.25 to 7.82)	43 per 1000	217 per 1000	174 more per 1000 (97 more to 293 more)	**Very low** Downgraded for risk of bias[b,c] and intransitivity[d]
Non-operative treatment (No direct evidence, indirect evidence only)	**RR 5.41** (1.80 to 16.26)	43 per 1000	233 per 1000	190 more per 1000 (34 more to 656 more)	**Very low** Downgraded for risk of bias[b,c] and intransitivity[d]
Cemented modern unipolar hemiarthroplasty	Reference comparator	-	-	-	Reference comparator

*Anticipated absolute effects compare two risks by calculating the difference between the risk with the intervention group and the risk with the comparison/control group (reference comparator).

CI: confidence interval; **NMA:** network meta-analysis; **RR:** risk ratio

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GRADE Working Group grades of evidence
High certainty: we are confident that the true estimate lies close to the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate. The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate. The true effect is likely to be substantially different from the estimate of the effect

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[a]Network estimate derived from direct evidence and indirect evidence (number of studies and participants is for direct evidence contributing to the network estimate)
[b]Risk of bias: all studies in direct and indirect estimates had high risks of detection bias, as well as unclear risks of bias in at least one other domain (downgraded by one level)
[c]Risk of bias: studies in direct or indirect estimates (or both) had high risks of selection bias or 'other bias' (downgraded by one level)
[d]Intransitivity: indirect estimates included variation in numbers of displaced fractures and intransitivity may be evident (downgraded by one level)
[e]Imprecision: confidence interval in the network estimate included benefits as well as harms (downgraded by one level)

BACKGROUND

This review has been written in accordance with guidance for authors on preparing a protocol for a systematic review with multiple interventions (Chaimani 2017; CMIMG 2014).

Description of the condition

Epidemiology

A hip fracture, or proximal femoral fracture, is a break in the upper region of the femur (thigh bone) between the subcapital region (the area just under the femoral head) and 5 cm below the lesser trochanter (a bony projection of the upper femur). The incidence of hip fractures rises with age; they are most common in the older adult population (Court-Brown 2017; Kanis 2001). Those in younger adults are usually associated with poor bone health (Karantana 2011; Rogmark 2018). A very small proportion of fractures in younger people are caused by high-energy trauma, such as road traffic collisions, industrial injuries and sports injuries. The overwhelming majority of hip fractures are fragility fractures associated with osteoporosis; such fractures are caused by mechanical forces that would not ordinarily result in fracture. The World Health Organization has defined fragility fractures as those sustained from injuries equivalent to a fall from a standing height or less (Kanis 2001). In the UK, the mean age of a person with hip fracture is 83 years, and approximately two-thirds occur in women (NHFD 2017).

Hip fractures are a major healthcare problem at the individual and population level. They present a huge challenge and burden to individuals, healthcare systems and society. The increased proportion of older adults in the world population means that the absolute number of hip fractures is rising rapidly across the globe. For example, in 2016 there were 65,645 new presentations of hip fracture to 177 trauma units in England, Wales and Northern Ireland (NHFD 2017). Based on population estimates for these regions for mid-2016, this equates to an incidence rate of 109 cases per 100,000 population (ONS 2016). By 2050, it is estimated that the annual worldwide incidence of hip fracture will be 6 million (Cooper 2011; Johnell 2004). Incident hip fracture rates are higher in industrialised countries than in developing countries. Northern Europe and the USA have the highest rates of hip fracture, whereas Latin America and Africa have the lowest (Dhanwal 2011). European studies show that there are more hip fractures in the north of the region than in the south, and there is a similar north-south gradient in the USA (Dhanwal 2011). Factors thought to be responsible for this variation are population demographics (with older populations in countries with higher incidence rates) and the influence of ethnicity, latitude, and environmental factors such as socioeconomic deprivation (Bardsley 2013; Cooper 2011; Dhanwal 2011; Kanis 2012).

Burden of disease

Hip fractures are associated with a high risk of death. For example, in England, Wales and Northern Ireland, the 30-day mortality rate in 2016 remained high at 6.7% despite a decline from 8.5% in 2011 and 7.1% in 2015 (NHFD 2017). The mortality rate one year after a hip fracture is approximately 30%; however, fewer than half of deaths are attributable to the fracture itself, which reflects the frailty of the patients and associated high prevalence of comorbidities and complications (Parker 1991; SIGN 2009). The impact of morbidity associated with hip fractures is similar to that of stroke, and entails a substantial loss of healthy life-years in older people (Griffin 2015).

Hip fractures commonly result in reduced mobility and greater dependency, with many people failing to return to their pre-injury residence. In addition, the public health impact of hip fractures is significant: data from large prospective cohorts show the burden of disease due to hip fracture is 27 disability-adjusted life years (DALYs) per 1000 individuals, which equates to an average loss of 2.7% of the healthy life expectancy in the population at risk of fragility hip fracture (Papadimitriou 2017). The direct economic burden of hip fractures is also substantial. Hip fractures are amongst the most expensive conditions seen in hospitals; the aggregated cost for 316,000 inpatient episodes in the USA in 2011 was nearly USD 4.9 billion (USD 4900 million; Torio 2011). In England, Wales and Northern Ireland, people with hip fracture occupy 1.5 million hospital bed days each year, and cost the National Health Service and social care GBP 1 billion (GBP 1000 million; NHFD 2017). Combined health and social care costs incurred during the first year following a hip fracture has been estimated at USD 43,669, which is greater than the cost for non-communicable diseases, such as acute coronary syndrome (USD 32,345) and ischaemic stroke (USD 34,772) (Williamson 2017). In established market economies, hip fractures represent 1.4% of the total healthcare burden (Johnell 2004)

Intracapsular hip fracture

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

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

Description of the intervention

Internationally, many guidelines exist concerning the management of hip fracture (e.g. AAOS 2014; Mak 2010; NICE 2017; SIGN 2009). Each recommend that early surgical management, generally within 24 to 48 hours, is the mainstay of care for the majority of hip fractures. The overall goal of surgery in the older population is to facilitate early rehabilitation, which enables early mobilisation and the return to premorbid function, while minimising the complication risk. This approach has been associated with reductions in mortality in many worldwide registries (Neufeld 2016; Sayers 2017).

For intracapsular fractures that are treated surgically, two types of operative strategy are commonly employed: joint preserving surgery (where the fracture is fixed with various types of internal fixation), or prosthetic replacement with any one of a number of arthroplasty options. Descriptions — and a proposed grouping — of interventions is given in Table 1.

Internal fixation

Once the decision is made to preserve the hip joint, the surgeon must elect whether to reduce or fix the fracture in situ. In general, displaced fractures must be reduced and undisplaced fractures are fixed in situ. Quality of the reduction is an important predictor of a successful outcome after fixation. Typically, fragility fractures are reduced closed, under X-ray control using an image intensifier. However, if a fracture is irreducible using closed means, it may be reduced open (exposed surgically to aid reduction). The reduced fracture is then held by an implant passed across the fracture under X-ray guidance. This may then be secondarily attached to a plate, which is attached to the outer aspect of the femur. These plates are designed to create an angular-stable implant that may confer biomechanical advantages to the bone-implant construct.

Numerous implants have been developed over time for the internal fixation of fractures. Implants may be divided into those which are smooth (pins) and those which are threaded (screws). The diameter, thread depth and pitch and core of these screws each vary. In addition, the proportion of the screw which is threaded may vary, from the tip only to the entire length. The number of pins or screws inserted across the fracture can range 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.

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

Arthroplasty

Arthroplasty entails replacing part or all of the hip joint with an endoprosthesis, an implant constructed of non-biological materials such as metal, ceramic or polyethylene. Arthroplasties can be grouped into two main categories: hemiarthroplasty (where only the femoral head and neck are replaced) and total hip replacement (where both the femoral head and the acetabulum or socket are replaced).

Hemiarthroplasty

Hemiarthroplasty involves replacing the femoral head with a prosthesis whilst retaining the natural acetabulum and acetabular cartilage. The type of hemiarthroplasty can be broadly divided into two groups: unipolar and bipolar. In unipolar hemiarthroplasties the femoral head is a solid block of metal. Bipolar femoral heads include a single articulation which allows movement to occur, not only between the acetabulum and the prosthesis, but also at this joint within the prosthesis itself.

The best-known of the early hemiarthroplasty designs are the Moore prosthesis (1952) and the FR Thompson Hip Prosthesis (1954). These are both monoblock implants and were designed before the development of poly(methyl methacrylate) bone cement; they were therefore originally inserted as a 'press fit'. The Moore prosthesis has a femoral stem, which is fenestrated, and also has a square stem with a shoulder to enable stabilisation within the femur, which resists rotation within the femoral canal. It is generally used without cement and, in the long term, bone in-growth into the fenestrations can occur. The Thompson prosthesis has a smaller stem without fenestrations and is now often used in conjunction with cement. Numerous other designs of unipolar hemiarthroplasties exist, based on stems that have been used for total hip replacements.

In bipolar prostheses, there is an articulation within the femoral head component itself. In this type of prosthesis, there is a spherical inner metal head with a size between 22 to 36 millimetres in diameter. This fits into a polyethylene shell, which in turn is enclosed by a metal cap. The objective of the second joint is to reduce acetabular wear by promoting movement at the interprosthetic articulation rather than with the native acetabulum. There are a number of different types of prostheses with different stem designs. Examples of bipolar prostheses are the Charnley-Hastings, Bateman, Giliberty and the Monk prostheses, but many other types with different stem designs exist.

Total hip replacement

Total hip replacement involves the replacement of the acetabulum in addition to the femoral head. The first successful total hip replacement was developed by John Charnley, using metal alloy femoral heads articulating with polyethylene acetabular components. Subsequently, the articulating materials have diversified: designs using metal alloys, ceramics and various polyethylenes in various combinations have all been used.

Component fixation

Irrespective of the nature of the articulating surfaces, the components must be fixed to the bone to ensure longevity of the arthroplasty. The two approaches used to achieve this fixation are cemented and uncemented designs.

Cemented systems

In this approach, poly(methyl methacrylate) bone cement may be inserted at the time of surgery. It sets hard and acts a grout between the prosthesis and the implant at the time of surgery. Potential advantages of cement are a reduced risk of intra-operative fracture and later periprosthetic fracture, and that it does not rely on integration of the prosthesis with osteoporotic bone. Major side effects of cement are cardiac arrhythmias and cardio-respiratory collapse, which occasionally occur following its insertion. These complications may be fatal; the cause is either embolism from marrow contents forced into the circulation (Christie 1994), or a direct toxic effect of the cement.

Uncemented systems

Uncemented systems rely on osseous integration forming a direct mechanical linkage between the bone and the implant. A prosthesis may be coated with a substance such as hydroxyapatite which promotes bone growth into the prosthesis. Alternatively, the surface of the prosthesis may be macroscopically and microscopically roughened so that bone grows onto the surface of the implant.

The complications of arthroplasty are those that are general to surgical management of hip fracture - for example, pneumonia, venous thromboembolism, infection, acute coronary syndrome and cerebrovascular accident - and those that are specific to arthroplasty, including dislocation of the prosthesis, loosening of the components, acetabular wear and periprosthetic fracture.

Non-operative management

Although the majority of intracapsular fractures are treated surgically, some people have non-operative or conservative treatment, which can involve traction, bed rest or restricted mobilisation (Handoll 2008). Non-operative treatment may be acceptable where modern surgical facilities are unavailable, where low income or different systems of care preclude an individual's access to surgery, or in medically unfit people with an unacceptably high risk of perioperative death. Non-operative treatment has been found to result in secondary fracture displacement of up to 62%, increased medical complications, higher mortality rates and poor functional outcomes (Lowe 2010; Rozell 2016; Van de Ree 2017).

Why it is important to do this review

Despite previous efforts to establish standardised hospital care pathways, the indications for certain treatment options in the management of intracapsular fractures varies among orthopaedic surgeons. The question of which surgical treatments are optimum has been debated for decades (Chua 1997; Dickson 1953; Garden 1961; Parker 2006a), and depends on many factors, including age and comorbidities of the individual and type of fracture.

Numerous randomised controlled trials have compared pairs of different treatments, including internal fixation, hemiarthroplasty and total hip replacement. Additionally, several systematic reviews and meta-analyses have made direct comparisons of many different pairs of interventions, for example: different types of hemiarthroplasty (e.g. cemented versus uncemented; unipolar versus bipolar (Li 2013; Liu 2014; Parker 2010a); internal fixation versus hemiarthroplasty (Dai 2011; Parker 2006b); internal fixation versus total hip replacement (Parker 2006b); and total hip replacement versus hemiarthroplasty (Burgers 2012; Hopley 2010). Generally, the meta-analyses of these treatments are inconclusive, due to heterogeneity between trials and a lack of high-quality data for some comparisons.

It is difficult to determine the most effective treatment option for intracapsular fractures from the results of conventional pair-wise meta-analyses of direct evidence for three reasons:

- some pairs of treatments have not been directly compared in a randomised controlled trial;
- sometimes the direct evidence does not provide sufficient data and we need to support it with indirect evidence;
- there are frequently multiple overlapping comparisons that potentially give inconsistent estimates of effect.

A network meta-analysis (NMA) overcomes these problems by simultaneously synthesising direct and indirect evidence (comparisons of treatments that have not been tested in a randomised controlled trial). For each outcome, an NMA provides estimates of effect for all possible pairwise comparisons. This allows the ranking of different interventions in order of effectiveness, and an assessment of their relative effectiveness.

This Cochrane NMA has been developed in parallel with a sister NMA on surgical interventions for treating extracapsular hip fractures in older adults (Lewis 2022a).

OBJECTIVES

To assess the relative effects (benefits and harms) of all surgical treatments used in the management of intracapsular hip fractures in older adults, using a network meta-analysis of randomised trials, and to generate a hierarchy of interventions according to their outcomes.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) and quasi-RCTs assessing surgical interventions for the management of people with intracapsular hip fracture. Quasi-RCTs are defined as trials in which the methods of allocating people to a trial are not random, but are intended to produce similar groups when used to allocate participants (Cochrane 2018). Studies published as conference abstracts were eligible for inclusion in the review, provided sufficient data relating to the methods and outcomes of interest were reported. We also considered unpublished data for inclusion.

Types of participants

Population

The fundamental assumption underpinning a network meta-analysis is that of transitivity (Caldwell 2005; Cipriani 2013). This implies that the distribution of potential treatment effect modifiers is balanced across the available direct comparisons. Therefore, we assume that any participant who meets the inclusion criteria below is, in principle, equally able to have been randomised to any of the eligible interventions examined in this review; that is, they are 'jointly randomisable' (Salanti 2012).

We included older adults (at least 60 years of age) undergoing surgery in a hospital setting for a fragility intracapsular hip fracture; we included displaced or undisplaced fractures which we expected to be caused by low-energy trauma.

We expected trial populations to have a mean age of between 80 and 85 years, to include 70% women, 30% with chronic cognitive impairment, and 50% with an American Society of Anesthesiologists (ASA) score greater than two (NHFD 2017; NICE 2017); this would be representative of the general hip fracture population.

We excluded studies that focused exclusively on the treatment of participants younger than 16 years of age, of participants with fractures caused by specific pathologies other than osteoporosis, and of participants with high-energy fractures. However, we took a pragmatic approach to study inclusion criteria, and included studies with mixed populations (fragility and other mechanisms, ages or pathologies). We expected that the proportion of participants with standard fragility fractures was most likely to outnumber those with high-energy or local pathological fractures; therefore, the results will be generalisable to the fragility fracture population. If data were reported separately for standard fragility

fractures, we planned to use this subgroup data in our main analysis. However, we excluded studies if we noted baseline characteristics indicated that participants were not representative of the general hip fracture population. We considered it unlikely that participants under 60 years of age would have experienced a fragility intracapsular hip fracture caused by low-energy trauma.

Types of interventions

We included trials comparing at least two of the competing interventions in the synthesis set. All the eligible interventions are assumed to be legitimate treatment alternatives for people with intracapsular fractures and therefore 'jointly randomisable'. We expected randomised groups to be similar with respect to co-interventions.

We included the following interventions.

- Any implant used for internal fixation of an intracapsular hip fracture.
- All hip endoprostheses: unipolar hemiarthroplasty (HA), bipolar HA, or total hip arthroplasty (THA; small and large head; single articulation or dual-mobility) — applied with or without cement.
- Non-operative treatment: including treatment with or without traction.

Grouping interventions

We spoke to our clinical authors and the International Fragility Fracture Network in preparation for this review to group possible interventions into homogeneous therapeutic categories. We present these categories in Table 1, and we updated this table to also include all interventions included within studies in this review. These interventions, or sufficiently similar variations of these interventions, are all potentially still in clinical use worldwide.

These categories formed the main nodes of the network. With our clinical authors, we explored differences within these nodes and made decisions on whether to group or split the nodes. This was guided by the data as well as considering the underlying assumptions (such as whether merging insufficiently similar interventions might violate transitivity).

We did not identify any unexpected interventions while searching for eligible studies. In this event, we had planned to consider these based on the context and whether they provided information to the network via a closed loop of treatment effects.

Types of outcome measures

We extracted data on the following critical outcomes.

- Mortality.
- Health-related quality of life (HRQoL): measured using recognised scores such as Short-Form 36 (Ware 1992) or EuroQol-5D (EQ-5D) (Dolan 1997; EQ-5D).
- Unplanned return to theatre: secondary procedure required for a complication resulting directly or indirectly from the index operation/primary procedure.

We chose these outcomes by considering all relevant outcomes of benefit and harm, and also by taking into account input from our stakeholder workshop (Sreekanta 2018).

Depending on the length of follow-up reported, we categorised the endpoints for mortality and HRQoL into 'early' (up to and including four months), 12 months (prioritising 12-month data, but in its absence including data after 4 months and up to 24 months), and 'late' (after 24 months). We reported data at each of these time points for these two outcomes. For unplanned return to theatre, we extracted outcome measures at the end of study follow-up.

Search methods for identification of studies

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

Electronic searches

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

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

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

We scanned ClinicalTrials.gov (www.clinicaltrials.gov/) for ongoing and unpublished trials on 10 July 2020.

Searching other resources

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

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

Data collection and analysis

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

Selection of studies

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

Data extraction and management

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

- Study methodology: publication type; sponsorship/funding/notable conflicts of interest of trial authors; study design; number of centres and locations; size and type of setting; study inclusion and exclusion criteria; randomisation method; number of randomised participants, losses (and reasons for losses), and number analysed for each outcome. (Collecting information relating to the participant flow helped the assessment of risk of attrition bias.)
- Population: baseline characteristics of the participants by group and overall (age, gender, smoking history, medication, body mass index (BMI), comorbidities, functional status such as previous mobility, place of residence before fracture, cognitive status, American Society of Anesthesiologists (ASA) status, fracture type and stability). This included data on the clinical and methodological variables that can act as effect modifiers across treatment comparisons. For intracapsular hip fractures, these have been identified as age, gender, baseline comorbidity, fracture displacement and cognitive status.
- Interventions: details of each intervention (number and type, manufacturer details); general surgical details (number of clinicians and their skills and experience, perioperative care such as use of prophylactic antibiotics or anti-thromboembolics, mobilisation or weight-bearing protocols).
- Outcomes: all outcomes measured or reported by study authors; outcomes relevant to the review (to include measurement tools and time points of measure); extraction of outcome data into data and analysis tables in Review Manager 2014.

We extracted this data in agreement with recommendations in the DECiMAL (Data Extraction for Complex Meta-Analysis) guide developed by Pedder and colleagues, which optimises data extraction for NMAs (Pedder 2016).

Assessment of risk of bias in included studies

One review author independently assessed risk of bias in the included studies using the Cochrane risk of bias tool (Higgins 2011a); a second author checked these decisions and a final judgement was made through discussion, if required. We assessed the following domains.

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

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

Measures of treatment effect

Summary measures

At each data point, we extracted either:

- mean or mean change from the baseline and standard deviations (SDs) per arm, or the information from which SDs could be derived, such as standard error or confidence interval (CI) for continuous outcomes;

- number of events per arm.

If a trial presented outcomes at more than one time point, we extracted data for all relevant time points. We included three time points in the review for mortality and HRQoL: 'early' (up to and including four months), 12 months (prioritising 12-month data, but in its absence including data after four months and up to 24 months), and 'late' (after 24 months).

Relative treatment effects

Studies reported HRQoL using different measurement tools and we therefore pooled data using standardised mean difference (SMD) (Hedges's adjusted g). We entered data presented as a scale with a consistent direction of effect across studies.

For dichotomous outcomes, we reported the risk ratio (RR) and 95% CI. Results from NMA are presented as summary relative effect sizes — SMD or risk ratio (RR) — for each possible pair of treatments. For SMDs, we calculated a mean difference (MD) on the EQ-5D utility scale using a standard deviation (SD) of 0.27 which was derived from the median SD reported by studies in the reference comparator group (Schünemann 2019). A SMD of 0.3 translates to a MD of 0.081 on the EQ-5D scale; this would indicate a minimal clinically important difference (MCID) between interventions within a MCID threshold range of 0.05 to 0.08 (Walters 2005).

Relative treatment ranking

For each outcome at each of the three points, we obtained a treatment hierarchy using the surface under the cumulative ranking curve (SUCRA), which is used to evaluate superiority of different treatments (Konig 2013; Mavridis 2015; Rucker 2015; Salanti 2008b; Salanti 2011; Salanti 2012). Generally, a larger SUCRA means a more effective intervention. We expressed SUCRA as a proportion (range 0 to 1.0). The higher the SUCRA value, the more likely the outcome of the respective treatment would be ranked first, or at least near the top of the rankings. Computations for SUCRA values were implemented in Stata (Stata), using the command 'sucra' (Chaimani 2013; Rucker 2015; Salanti 2011). We also calculated the estimated proportion of times each intervention would be ranked in each order position (from best to worst treatment) and from this, we presented an estimated mean rank for each intervention for each outcome (at all three time points).

Unit of analysis issues

Alternative trial designs

We did not encounter any within-person randomised trials or cluster-randomised trials.

Reports of outcomes at different time points

When preparing the review, we found that outcomes were reported at a wider range of 'late' time points than we had anticipated. Following discussion with our clinical authors, we grouped these into three time points; we maintained an early time point (up to four months after surgery) and adopted two later time points - one that prioritised data at 12 months (between four months and 24 months), and a final time point later than 24 months after surgery (which included final study follow-up) (see Differences between protocol and review).

Studies with multiple treatment groups

We included multi-armed trials and accounted for the correlation between the effect sizes in the network meta-analysis. We followed guidance provided in the *Cochrane Handbook* on dealing with multiple groups from one study (Higgins 2011b), and NMA (Higgins 2011c).

We assumed that studies of different comparisons were similar in all ways apart from the interventions being compared.

Dealing with missing data

For each included study, we recorded the number of participant losses for each outcome. Unless reported otherwise, we assumed complete case data for mortality and unplanned return to theatre. For outcomes that required participant assessment at end of follow-up (i.e. HRQoL), we prioritised intention-to-treat (ITT) data where these data were available. If ITT data were unavailable for these outcomes, and if study authors did not clearly report denominator figures for each group for the outcome, we reduced the denominator figure in each group to account for reported mortality. We did not impute missing data. We used the risk of bias tool to judge attrition bias. We judged studies to be at high risk of attrition bias if we noted large amounts of unexplained missing data, loss that could not be easily justified in the study population, or losses that were not sufficiently balanced between intervention groups.

Assessment of clinical and methodological heterogeneity within treatment comparisons

We assessed clinical and methodological diversity in terms of participants, interventions, outcomes and study characteristics for the included studies to determine whether a meta-analysis was appropriate. We conducted this assessment by generating the descriptive statistics for trial and study population characteristics across all eligible trials that compared each pair of interventions, and observing these data from the data extraction tables.

Assessment of transitivity across treatment comparisons

We assessed the assumption of transitivity by comparing the distribution of the potential effect modifiers (such as displaced or undisplaced fractures) across the different pairwise comparisons to ensure that they were, on average, balanced. We assessed control groups for their similarity across treatment comparisons.

Geometry of the network

Different eligibility criteria for interventions will result in different collections of evidence in the synthesis, and because of the inter-relationships across direct and indirect evidence, this can lead to different effect estimates and relative rankings. We provided a qualitative description of network geometry accompanied by a network diagram of all competing interventions. The diagram gives a comprehensive definition of the nodes in the network and gives an indication of the volume of evidence within each comparison. It also gives a visual representation of the possible comparisons where any two modalities are compared.

We evaluated the quantitative metrics by assessing features of network geometry: the size of the nodes reflects the amount of evidence accumulated for each treatment (total number of participants) and the breadth of each edge is proportional to

the inverse of the variance of the summary effect of each direct treatment comparison (Salanti 2008a). To understand which are the most influential comparisons in the network, and how direct and indirect evidence influences the final summary data, we used a contribution matrix that describes the percentage contribution of each direct meta-analysis to the entire body of evidence (Chaimani 2015).

Presentation of results

We presented the following in our review, based on Salanti 2011.

- A network diagram.
- A network forest plot.
- Direct (the observed data), indirect and combined network estimates - each reported in a single triangle table.
- Treatment rankings.
- Summary of findings tables for the primary networks accompanied by a forest plot of treatment effects.

Assessment of heterogeneity

Assumptions when estimating the heterogeneity

The network model allows for heterogeneity between studies within trial design by incorporating a study-specific random effect. In standard pairwise meta-analyses, we estimated different heterogeneity variances for each pairwise comparison. In NMA, we assumed a common estimate for the heterogeneity variance across the different comparisons.

Measures and tests for heterogeneity

Pairwise comparisons

We assessed statistical heterogeneity within each pairwise comparison by visual inspection of the forest plots to detect any large differences of intervention effects across included studies. If the studies are estimating the same intervention effect, there should be overlap between the CIs for each effect estimate on the forest plot. However, if overlap is poor, or there are outliers, then statistical heterogeneity may be likely.

We used Stata to perform pairwise meta-analysis (Stata). We produced the Chi^2 statistic, which is the test for heterogeneity, and the I^2 statistic, which is the test used to quantify heterogeneity and which calculates the proportion of variation due to heterogeneity rather than due to chance. A P value less than 0.10 was considered to be indicative of statistical heterogeneity.

The I^2 value ranges from 0% to 100%, with higher values indicating greater heterogeneity. As recommended in the *Cochrane Handbook*, an I^2 value of 0% to 40% may be interpreted as "might not be important"; 30% to 60% as "may represent moderate heterogeneity"; 50% to 90% as "may represent substantial heterogeneity"; and 75% to 100% as "considerable heterogeneity" (Deeks 2019).

Entire network

We did not formally assess statistical heterogeneity in the entire network as planned, based on the magnitude of the heterogeneity variance parameter estimated from the NMA models (Jackson 2014). Due to the limited number of studies relative to the number of interventions in the network models, common standard deviations were assumed. For dichotomous outcomes, we informally compared the magnitude to the distribution of estimates as derived by Turner 2012. For 12 months HRQoL only, where a SMD was produced, we used the same approach, using the distribution of estimates produced by Rhodes 2015. The between-study variance could not be assessed in this way for early and late HRQoL since fixed-effect models were used due to the small number of studies.

Assessment of reporting biases

Standard systematic reviews consider the impact of possible reporting biases and small-study effects (e.g. funnel plots and Egger's test). These approaches have been extended for NMAs and we explored this when more than 10 relevant studies were available. We produced comparison-adjusted plots using the 'netfunnel' command in Stata to investigate any relationship between effect estimates and study size or precision (Chaimani 2012; Chaimani 2013). For the comparison-adjusted funnel plot, we ordered interventions from the oldest to newest treatments in the entire evidence base using date of publication as a proxy for old to new. We anticipated that published small trials may tend to be biased in the direction of new treatments. We did not attempt to run network meta-regression models to detect associations between study size and effect size as originally planned.

Data synthesis

Methods for direct treatment comparisons

Initially, for every treatment comparison for each outcome with at least two studies, we performed standard pairwise meta-analyses using a random-effects model in Stata (Stata; White 2015); we performed this analysis for each outcome at each of the three time points. If any problems were evident with convergence, we re-analysed the data using a fixed-effect model (White 2015). See Assessment of heterogeneity.

Methods for indirect and mixed comparisons

For each pairwise comparison, we synthesised data to obtain summary SMDs for continuous outcomes or RRs for dichotomous outcomes; we evaluated all three outcomes at each of the three time points. If the collected studies appeared to be sufficiently similar with respect to the distribution of effect modifiers, we conducted a random-effects NMA to synthesise all evidence for each outcome and obtain a comprehensive ranking of all treatments. We conducted the NMA model with contrast-level data by running the consistency and inconsistency (design by treatment interaction) models, using multivariate meta-analysis approaches within the frequentist framework (White 2015). We used the network suite of Stata commands (Stata).

Assessment of statistical inconsistency

We evaluated the statistical inconsistency — which is the statistical disagreement between direct estimates (from direct comparisons of treatment) and indirect estimates (derived from the network comparisons) — by both local and global approaches, as follows (Chaimani 2017; Donegan 2013).

Global approaches for evaluating inconsistency

To check the assumption of consistency in the entire network, we used the 'design-by-treatment interaction' model (Higgins 2012; White 2012). This method accounts for different sources of

inconsistency that can occur when studies with different designs (two-armed trials versus three-armed trials) give different results, as well as disagreement between direct and indirect evidence. Using this approach, we inferred the presence of inconsistency from any source in the entire network based on a Chi^2 test. The design-by-treatment model was performed in Stata using the network commands (Stata). We presented the results of this overall approach graphically in a forest plot using the network forest command in Stata (Stata).

Local approaches for evaluating inconsistency

We evaluated the inconsistency between direct and indirect comparisons using a statistical approach referred to as 'node splitting', conducted with the 'sidesplit' command in Stata, when a closed triangle or quadratic loop connecting no less than three arms existed (Dias 2010).

Investigation of heterogeneity and inconsistency

If we found important heterogeneity or inconsistency (or both) across treatment comparisons, we planned to explore the possible sources. For intracapsular hip fractures, the effect modifiers have been identified as:

- age;
- gender;
- baseline comorbidity index;
- baseline functional status;
- cognitive status;
- fracture type.

However, there was insufficient variation between studies and a lack of reporting by subgroups for these effect modifiers within studies, and a corresponding network meta-regression analysis to explore these effect modifiers was not considered practical, given the number of studies and interventions.

Subgroup analysis and investigation of heterogeneity

Although we planned to subgroup the data according to fracture displacement, we found limited variation in displacement levels across most studies and therefore did not conduct subgroup analysis.

Sensitivity analysis

We did not conduct sensitivity analysis on the network estimates. See Differences between protocol and review.

Summary of findings and assessment of the certainty of the evidence

Credibility of the evidence

We used the GRADE approach to assess the certainty of the evidence for each outcome of interest in each paired comparison for which there is direct evidence (i.e. where two interventions have been compared in randomised trials). The GRADE system classifies evidence as 'high', 'moderate', 'low', or 'very low' certainty. The starting point for certainty in estimates for randomised trials is high, but for direct comparisons may be rated down based on limitations concerning risk of bias, inconsistency, indirectness and publication bias (Guyatt 2008). We presented our GRADE assessments in summary of findings tables.

We also used the GRADE approach to assess the certainty in indirect and network (mixed) effect estimates (Brignardello-Petersen 2018a; Puhan 2014). Using the 'node splitting' method, we calculated indirect effect estimates from the available 'loops' of evidence, including loops with a single common comparator (first order) or more than one intervening treatment (higher order) connecting the two interventions of the comparison of interest. To assess the certainty of evidence for each indirect comparison, we focused on the dominant first-order loop (i.e. the first-order loop that contributes most to the indirect estimate). For the certainty-of-evidence rating for indirect comparisons, we used the lower of the ratings of certainty for the two direct estimates contributing to the dominant first-order loop. For instance, if one of the direct comparisons was rated as low-certainty and the other as moderate-certainty evidence, we rated the certainty of indirect evidence as low.

For ratings of certainty for indirect comparisons, we also considered downgrading the certainty for intransitivity (Brignardello-Petersen 2018a; Puhan 2014). The transitivity assumption implies similarity of the bodies of evidence (for instance, the trials assessing A versus C and B versus C informing a comparison of A versus B) informing indirect comparisons in terms of population, intervention, outcomes, settings and trial methodology (Salanti 2008b).

If both direct and indirect evidence were available and yielded similar results, the NMA mixed-estimate certainty rating came from the higher certainty of the two that contribute substantially to the pooled estimate. If the direct and indirect estimates showed important differences (incoherence) — addressed by the difference in point estimates, the extent of overlap of CIs, and a statistical test of incoherence — we considered further downgrading the certainty assessment of the mixed NMA effect. Additionally, we also considered downgrading for imprecision in this estimate (Brignardello-Petersen 2018b).

Summary of findings tables

Typically, a summary of findings table presents the GRADE ratings, along with the intervention effects for the most important outcomes of the systematic review. In NMA, the comparison of multiple interventions is the main feature of the network and is likely to drive the structure of the tables. We followed the guidance for producing summary of findings tables for NMAs as outlined in Chapter 11 of the *Cochrane Handbook* (Chaimani 2018). Choosing the time points that yielded the most data, we produced a separate table for each outcome in the review:

- mortality at 12 months;
- HRQoL at 12 months; and
- unplanned return to the theatre at end of follow-up.

All interventions were of direct interest to our main conclusions and were included in the summary of findings tables. We selected a reference comparator against which all other treatments were compared, and we reported relative effect estimates, baseline risk information, certainty of the evidence for the NMA, judgements for downgrading the body of the evidence, and text with definitions of NMA aspects (e.g. absolute effects) (Yepes-Nuñez 2019).

RESULTS

Description of studies

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

Results of the search

After removal of duplicates from the search results, we screened 28,509 titles and abstracts, which included backward citation searches and searches of clinical trials registers. We reviewed the full texts of 1019 reports and selected 119 studies (with 215 records) for inclusion in this review. We excluded 781 records, and report the details of 21 key studies from these excluded records. Four studies are awaiting classification, and we identified 17 ongoing studies. See Figure 1.

Figure 1. PRISMA study flow diagram

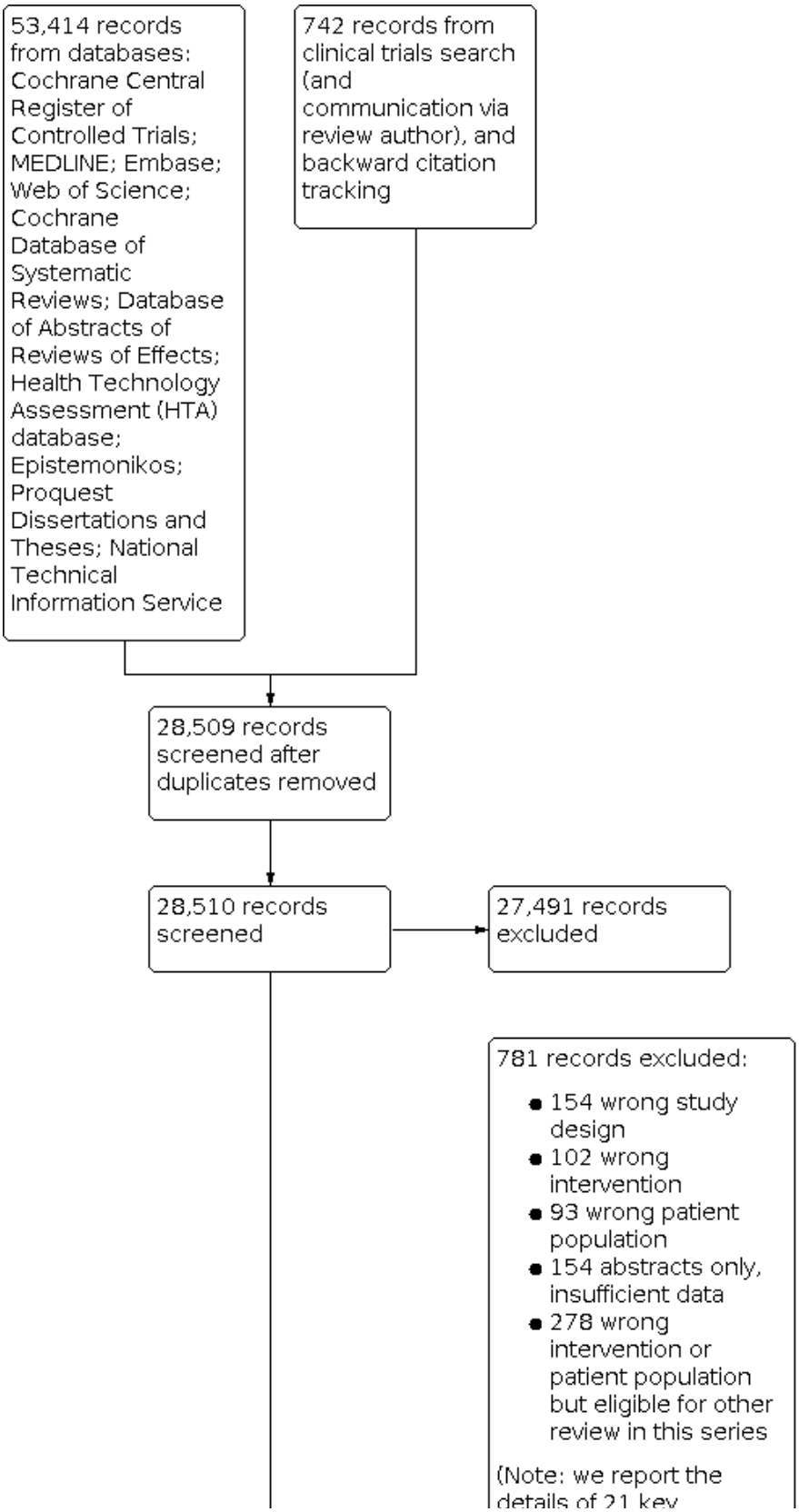
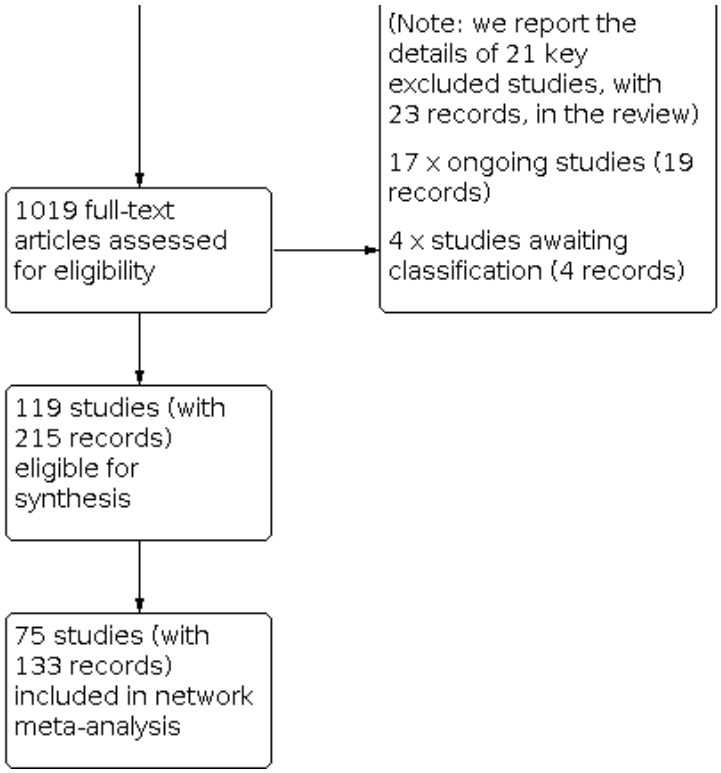


Figure 1. (Continued)



Included studies

See Characteristics of included studies. Four studies were reported only as abstracts with limited study characteristics (Ingwersen 1992; Moroni 2002; Ovesen 1997; Patel 2008). We noted that two studies were terminated early: Borris 2020 was terminated because of a high rate of implant-associated discomfort, and Sørensen 1992 was terminated because of a difference in failure rate between the two methods (study authors reported more failure when Gouffon screws were used).

Types of studies and setting

We included 119 studies (see Included studies). Seventeen studies used methods to allocate participants to interventions that we described as quasi-randomised (Abdelkhalek 2011; Chammout 2012; Dorr 1986; El-Abed 2005; Eschler 2014; Frandsen 1981; Iorio 2019; Lindequist 1989; Livesley 1993; Nordkild 1985; Ravikumar 2000; Santini 2005; Sonaje 2017; Soreide 1979; Stoffel 2013; Strömquist 1984; Strömquist 1988). Although we expected most other studies were randomised controlled trials, methods of randomisation were not always clearly reported.

Sixteen studies were conducted across multiple centres (Alho 1998; Baker 2006; Dolatowski 2019; FAITH 2017; Fernandez 2022; Figved 2009; HEALTH 2019; Kalland 2019; Kanto 2014; Keating 2006; Macaulay 2008; Moerman 2017; Rogmark 2002; Sims 2018; Talsnes 2013; Van den Bekerom 2010), and the remainder were completed at a single centre.

Studies were conducted in:

- Sweden (Alberts 1989; Blomfeldt 2005; Blomfeldt 2007; Chammout 2012; Chammout 2017; Chammout 2019; Cornell 1998; Dalen 1985; Elmerson 1988; Elmerson 1995; Hedbeck 2011; Hedbeck 2013; Herngren 1992; Holmberg 1990; Inngul 2015; Johansson 2014; Jonsson 1996; Kalland 2019; Lagerby 1998; Lindequist 1989; Mattsson 2003; Mattsson 2006; Olerud 1991; Rehnberg 1989; Sernbo 1990; Soreide 1979; Strömquist 1984; Strömquist 1988; Tidermark 2003; Wihlborg 1990);
- UK (Baker 2006; Brandfoot 2000; Calder 1995; Calder 1996; Christie 1988; Davison 2001; Emery 1991; Fernandez 2022; Griffin 2014; Griffin 2016; Harper 1994a; Harper 1994b; Keating 2006; Livesley 1993; Parker 2002; Parker 2010c; Parker 2010d; Parker 2012; Parker 2015; Parker 2019; Parker 2020; Ravikumar 2000; Sadr 1977; Sikorski 1981; Sims 2018);
- Norway (Alho 1998; Benterud 1997; Dolatowski 2019; Figved 2009; Figved 2018; Frihagen 2007; Ingwersen 1992; Lykke 2003; Mjørud 2006; Paus 1986; Svenningsen 1984; Talsnes 2013);
- Denmark (Borris 2020; Frandsen 1981; Madsen 1987; Nordkild 1985; Ovesen 1997; Sonne-Holm 1982; Sørensen 1992);
- China (Cao 2014; Liu 2017; Lu 2017; Ren 2017; Wei 2020; Xu 2017);
- India (Malhotra 1995; Pathi 1989; Sharma 2016; Sonaje 2017);
- Italy (Cadossi 2013; Iorio 2019; Moroni 2002; Santini 2005);
- The Netherlands (Moerman 2017; Van den Bekerom 2010; Van Dortmont 2000; Van Vugt 1993);
- USA (DeAngelis 2012; Dorr 1986; Macaulay 2008; Raia 2003);
- Australia (Jeffcote 2010; Stoffel 2013; Watson 2013);
- Finland (Kanto 2014; Kuokkanen 1991; Puolakka 2001);
- South Korea (Kim 2012; Lim 2020);
- Egypt (Abdelkhalek 2011; Rashed 2020); and
- one study in each of Croatia (Vidovic 2013), Germany (Eschler 2014), Greece (Mouzopoulos 2008), Iran (Motififard 2010), Ireland

(El-Abed 2005), New Zealand (Taylor 2012), Pakistan (Rehman 2014) and Slovenia (Movrin 2020).

Two studies were international studies: FAITH 2017 recruited participants from Australia, Canada, Germany, India, the Netherlands, Norway, UK and the USA; and HEALTH 2019 recruited participants from Canada, Finland, the Netherlands, New Zealand, Norway, South Africa, Spain, UK and the USA.

Studies were published between 1977 and 2020. Approximately half of the studies were published since 2010.

Types of participants

In total, 17,653 participants with 17,669 intracapsular hip fractures were recruited across the 119 studies. Although some studies did not report baseline data, where these were reported, we noted that 83% of fractures were displaced. Most participants were randomised within three days of injury, but two studies were within four days (Borris 2020; FAITH 2017), one study within a week (Sonne-Holm 1982), and one within three weeks (Pathi 1989). Only one study recruited participants that had neglected fractures, more than 30 days old (Xu 2017).

Although some studies recruited participants from a younger starting age (e.g. at least 50 years or 55 years of age), we found that the mean age of participants in all studies (where reported) ranged from 60 to 87 years of age. The gender of participants was not reported in 14 studies (Christie 1988; Eschler 2014; Griffin 2016; Ingwersen 1992; Livesley 1993; Ovesen 1997; Patel 2008; Ravikumar 2000; Sonaje 2017; Sonne-Holm 1982; Soreide 1979; Stoffel 2013; Strömquist 1984; Svenningsen 1984). In those studies that reported gender distribution, there were 14,898 females, which represents 73% of the participants included in these studies.

Types of interventions

Studies included the following interventions.

- Total hip arthroplasties, used with: a standard single articulation; dual-mobility articulation; short stem; standard stem; and were cemented or uncemented.
- Hemiarthroplasties, used with: a modern or first-generation bipolar or unipolar head; short stem; standard stem; Exeter Trauma stem; Furlong stem; and were cemented or uncemented.
- Screws.
- Smooth pins.
- Fixed angle plates. Most plates used a dynamic design; only one study used a static fixed angle plate (Ingwersen 1992). We also included a Hansson Pinloc system (Kalland 2019), and a Dynaloc plate (Borris 2020). Whilst these designs differ from a standard fixed angle plate and are neither static or dynamic, we included them as fixed angle plates because they use a plate system.

Types of outcome measures

Seven studies did not report review outcomes (Calder 1995; Malhotra 1995; Mattsson 2003; Pathi 1989; Rehman 2014; Ren 2017; Stoffel 2013). The remaining studies reported data for at least one of the review outcomes.

Sources of funding and declarations of interest

Sixteen studies declared that non-commercial funding, such as from research foundations, was received (Blomfeldt 2005; Chammout 2019; Dalen 1985; Elmerson 1988; FAITH 2017; Fernandez 2022; Frihagen 2007; Griffin 2016; HEALTH 2019; Herngren 1992; Holmberg 1990; Jonsson 1996; Kalland 2019; Keating 2006; Macaulay 2008; Tidermark 2003). Twenty-eight studies confirmed that no funding was received and conflicts of interest did not exist (Baker 2006; Cadossi 2013; Calder 1996; Chammout 2012; Chammout 2017; Davison 2001; Emery 1991; Eschler 2014; Inngul 2015; Iorio 2019; Lim 2020; Livesley 1993; Lu 2017; Movrin 2020; Parker 2002; Parker 2010c; Parker 2010d; Parker 2012; Parker 2015; Parker 2019; Parker 2020; Rashed 2020; Santini 2005; Sonaje 2017; Van den Bekerom 2010; Vidovic 2013; Wei 2020; Xu 2017). Fifteen studies declared that commercial funding was received or that the study was supported in part (for example, with supply of implants) from manufacturers (Blomfeldt 2007; DeAngelis 2012; Dorr 1986; Figved 2009; Figved 2018; Hedbeck 2011; Harper 1994a; Harper 1994b; Mattsson 2003; Mattsson 2006; Raia 2003; Ravikumar 2000; Sims 2018; Talsnes 2013; Taylor 2012). Support was received from both independent and manufacturer sources in two studies (Griffin 2014; Watson 2013). The remaining studies reported no information about their funding sources nor provided declarations about conflicts of interest.

Excluded studies

Because the searches in this review were designed to feed into a series of related Cochrane Reviews about the surgical management of hip fracture, we have not included a bibliographic list of all excluded studies. We excluded most studies because they were study designs that were ineligible for inclusion in this review, or were not treating participants with the types of fracture or with the types of interventions that were eligible for this review. Some of the excluded studies were eligible for inclusion in the related Cochrane Reviews.

Here, we report the details of 21 key excluded studies (see Characteristics of excluded studies). We excluded eight studies because the mean age of participants was younger than the expected population for the type of fracture (FAITH-2 2020; Kumar 2015; Min 1999; Okcu 2015; Qiu 2016; Siavashi 2015; Yin 2016; Yu 2013). The decision to exclude younger participants was a change from our protocol (see Differences between protocol and review). We excluded eight studies because they were abstracts with insufficient detail on the numbers of participants in each group, meaning extraction of outcome data was not feasible (Jensen 1984; Karpman 1992; Kavcic 2006; Rosen 1992; Sernbo 1986; Sorensen 1996; Stock 1997; Van Thiel 1988). We excluded three studies that appeared to be randomised, but on closer inspection, we believed were not randomised (Bisaccia 2018; Dong 2019; Somashekar 2013). We excluded one study that investigated the surgical approach rather than the type of intervention (Aydin 2009), and one study from our clinical trials register search which was abandoned because of lack of funding and results are not reported (ISRCTN42349821).

Ongoing studies

We found 17 ongoing studies with estimated enrolment of 10,663 participants. These studies evaluate screws versus fixed angle plates (ChiCTR1800015618; ChiCTR1900022697; NCT04462172); smooth pins versus fixed angle plate (NCT02699619); screws

versus screws (ChiCTR1800015159); fixed angle plate versus fixed angle plate (Kalsbeek 2020); THA versus HA (ChiCTR1800019531; NCT01109862; UMIN000011303); cemented HA versus uncemented HA (NCT01787929); cemented THA versus uncemented THA (NCT01578408); dual mobility THA versus standard THA (Wolf 2020a); single versus dual antibiotic cement HA (ISRCTN15606075); targon femoral nail versus HA (NCT02996383); and arthoplasty versus internal fixation (ISRCTN28566489; NCT04075461; Wolf 2020b).

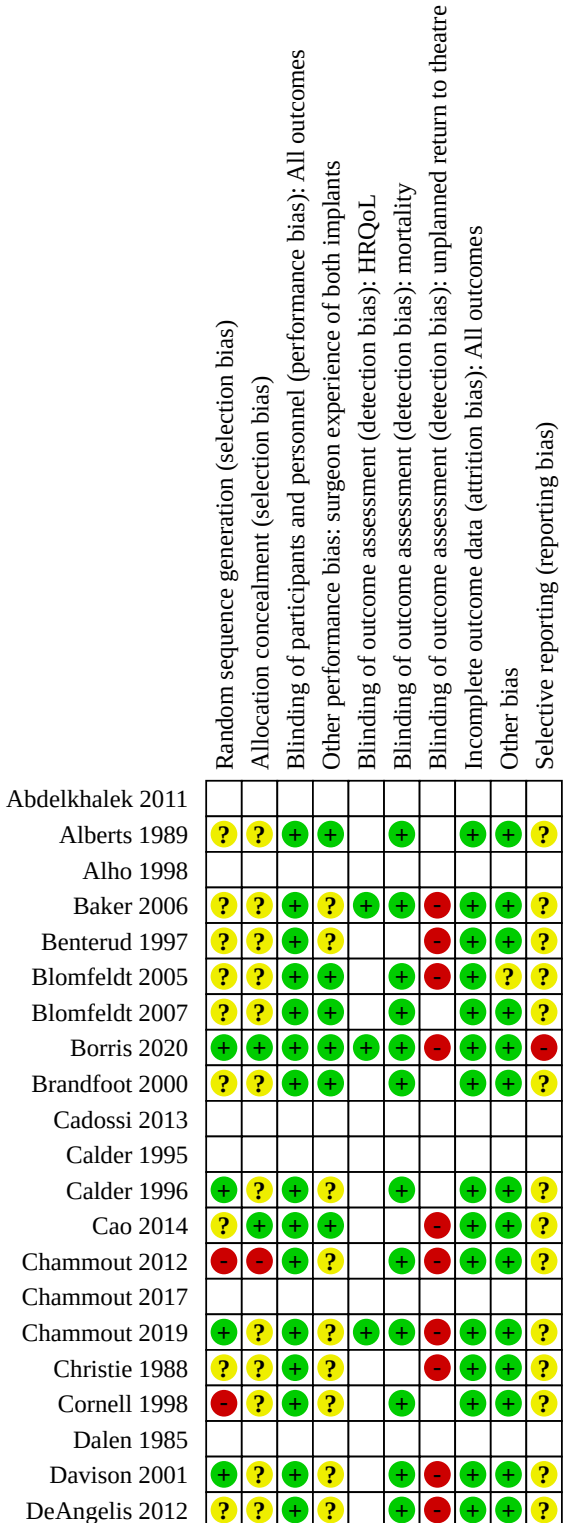
Awaiting classification

We found four studies from the search of clinical trial registries that were registered as completed but do not have a published study report in the literature (NCT00800124; NCT00859378; NCT01432691; NTR1782). These studies potentially recruited 1204 participants and investigated the following comparison groups: cemented HA versus uncemented HA (NCT00800124; NCT00859378; NTR1782), and THA versus HA (NCT01432691).

Risk of bias in included studies

See Figure 2. We only conducted risk of bias assessment for studies with outcome data included in the networks, and we conducted risk of detection bias separately for each outcome. Blank spaces in the risk of bias figure indicate that assessments were not completed for these studies or domains.

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



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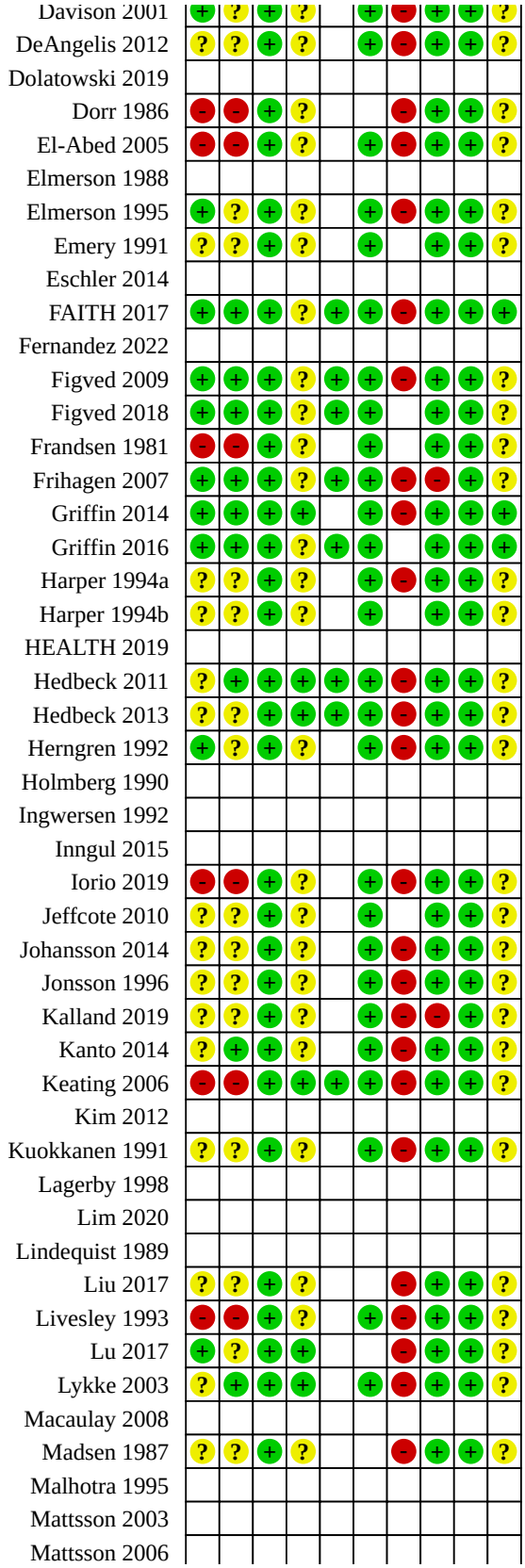

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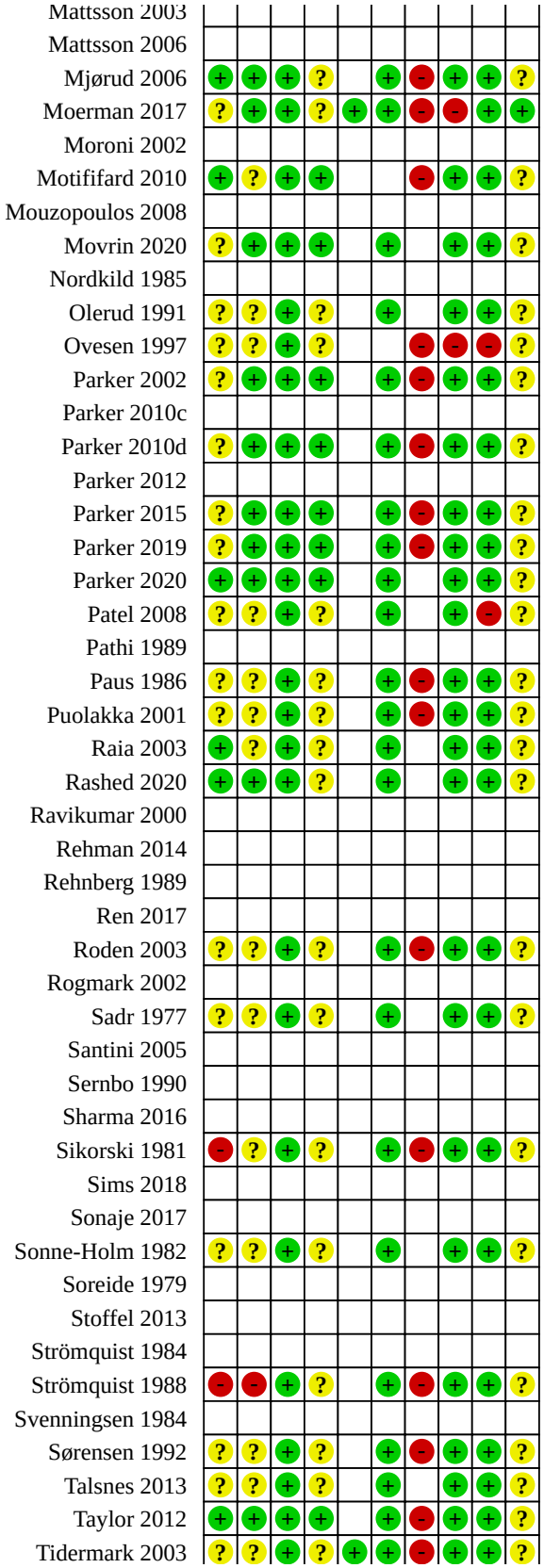

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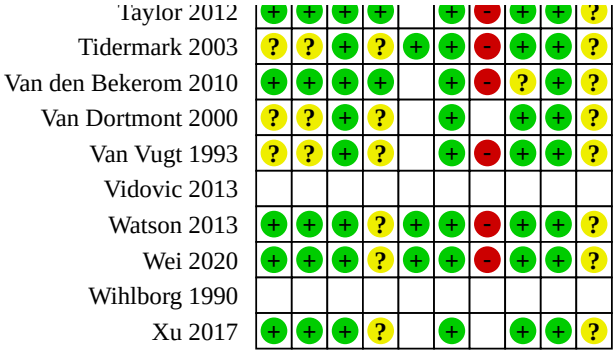


Allocation

Twenty three studies described adequate methods to randomise participants to treatment groups, and we judged these studies to be at low risk of selection bias for sequence generation (Borris 2020; Calder 1996; Chammout 2019; Davison 2001; Elmerson 1995; FAITH 2017; Figved 2009; Figved 2018; Frihagen 2007; Griffin 2014; Griffin 2016; Herngren 1992; Lu 2017; Mjørud 2006; Motififard 2010; Parker 2020; Raia 2003; Rashed 2020; Taylor 2012; Van den Bekerom 2010; Watson 2013; Wei 2020; Xu 2017). We judged nine studies to be at high risk of selection bias for sequence generation: these included quasi-randomised studies and studies in which we noted potential for bias from other information presented by study authors (Chammout 2012; Cornell 1998; Dorr 1986; El-Abed 2005; Frandsen 1981; Iorio 2019; Keating 2006; Livesley 1993; Sikorski 1981). The remaining studies reported insufficient information for us to judge risk of selection bias for sequence generation.

Twenty four studies described adequate methods to conceal allocation during the selection process and were at low risk of bias (Borris 2020; Cao 2014; FAITH 2017; Figved 2009; Figved 2018; Frihagen 2007; Griffin 2014; Griffin 2016; Hedbeck 2011; Kanto 2014; Lykke 2003; Mjørud 2006; Moerman 2017; Movrin 2020; Parker 2002; Parker 2010d; Parker 2015; Parker 2019; Parker 2020; Rashed 2020; Van den Bekerom 2010; Watson 2013; Wei 2020; Xu 2017). We judged all the quasi-randomised studies to be at high risk of bias for allocation concealment (Chammout 2012; Dorr 1986; Frandsen 1981; Iorio 2019; Livesley 1993; Strömquist 1988), as well as Keating 2006 which had a two-step randomisation process of which the first was at high risk of bias. The remaining studies reported insufficient information for us to be able to judge risk of bias for this domain.

Blinding

It is not possible to blind surgeons to the different study implants, but we did not expect that this lack blinding would introduce bias and we judged all studies to be at low risk of performance bias for blinding of personnel. However, we believed that the experience with the interventions may affect performance. We judged only 21 studies to be at low risk of performance bias caused by experience with the implants (Alberts 1989; Blomfeldt 2005; Blomfeldt 2007; Borris 2020; Brandfoot 2000; Cao 2014; Griffin 2014; Hedbeck 2011; Hedbeck 2013; Keating 2006; Lu 2017; Lykke 2003; Motififard 2010; Movrin 2020; Parker 2002; Parker 2010d; Parker 2015; Parker 2019; Parker 2020; Taylor 2012; Van den Bekerom 2010); in these studies, surgeons were equally experienced with study interventions. We were uncertain of bias in the remaining studies because study authors did not report this information.

We judged detection bias according to the type of outcome being measured. We expected that assessment of mortality was at low risk of detection bias in all studies. Although participants were not always blinded when providing assessment information for health-related quality of life, we also expected that detection bias for this outcome was low in all relevant studies. However, we believed that decisions on return to theatre were subjective, were likely to be made by unblinded surgeons, and we judged all studies reporting this outcome to be at high risk of detection bias.

Incomplete outcome data

We judged three studies to be at high risk of attrition bias because of unexplained losses affecting some or all of the outcomes (Kalland 2019; Moerman 2017; Ovesen 1997). We judged risk of attrition bias to be unclear in Van den Bekerom 2010: because the number randomised to each group was not reported, we could not determine whether data were complete for all participants. We judged attrition bias to be at low risk in the remaining studies.

Selective reporting

We judged four studies to be at low risk of selective reporting bias for all outcomes (FAITH 2017; Griffin 2014; Griffin 2016; Moerman 2017); these studies were all prospectively registered or registered shortly after commencement of the trial, and their reported outcomes were consistent with those in the clinical trials register documents. Borris 2020 was also prospectively registered with a clinical trials register but not all outcomes were reported; we judged unplanned return to theatre to be at low risk of selective reporting bias but other outcomes to be high risk because these outcomes were not reported in the clinical trials registration documents.

Eleven studies were retrospectively registered with a clinical trials register (Chammout 2012; Chammout 2019; DeAngelis 2012; Figved 2009; Figved 2018; Frihagen 2007; Kalland 2019; Kanto 2014; Parker 2019; Parker 2020; Wei 2020). It was not feasible to use these registration documents to assess risk of selective reporting bias. Two additional studies reported that their studies were registered, but because they provided no registration numbers, we could not confirm this or evaluate reporting bias (Talsnes 2013; Taylor 2012).

The remaining studies did not report prepublished protocols or clinical trials registration and we were unable to assess reporting bias.

Other potential sources of bias

We judged two studies to be at high risk of other bias because they were reported only in brief abstracts which we expected were not peer-reviewed (Ovesen 1997; Patel 2008). We noted a difference in clinical management between participant groups with prophylactic antibiotic use in Blomfeldt 2005; we judged risk of other bias to be unclear because we could not be certain whether this could influence participant outcomes. We identified no other sources of bias in the remaining studies.

Effects of interventions

See: **Summary of findings 1** Certainty of the effects and network estimates of surgical interventions for treating intracapsular hip fractures in older adults: mortality at 12 months; **Summary of findings 2** Certainty of the effects and network estimates of surgical interventions for treating intracapsular hip fractures in older adults: health-related quality of life at 12 months; **Summary of findings 3** Certainty of the effects and network estimates of surgical interventions for treating intracapsular hip fractures in older adults: unplanned return to theatre

Geometry of the networks

We produced networks for each of our specified outcomes and time points, as described in Types of outcome measures, yielding five different networks. The overall approach to development of these networks was driven principally by consideration of the clinical appropriateness of lumping/splitting the nodes in a series of meetings between the author group and representatives from the Fragility Fracture Network. Initially, two draft networks were produced for each outcome: a highly granular network where each distinct intervention from the included studies was represented by an individual node and then a highly collapsed network where nodes were lumped as much as was clinically plausible. The networks were then refined such that a balance was achieved between efficiency, where consideration was taken for how many studies could be included, and the best possible representation of the interventions and their component subtypes.

Although not all the final networks included all nodes, we defined 12 separate nodes across this review:

- uncemented first-generation bipolar HA;
- uncemented first-generation unipolar HA;
- uncemented modern bipolar HA;
- uncemented modern unipolar HA;
- cemented modern bipolar HA;
- cemented modern unipolar HA;
- THA with single articulation;
- THA with dual-mobility articulation;
- dynamic fixed angle plate;
- pins;
- screws; and
- non-operative.

The treatments in each network in this review were all connected (see Figure 3; Figure 4; Figure 5; Figure 6; Figure 7; Figure 8; Figure 9). Although we report here findings for all networks, we selected three of the networks as our principal measures of outcome, striking a balance between the availability of studies and data within each, and our prespecified instruments:

Figure 3. Network geometry for early mortality. The size of the nodes is proportional to the number of trials investigating each treatment, whilst the thickness of the edges is proportional to the number of direct comparisons. Treatment nodes - A: dynamic fixed angle plate; B: uncemented first-generation bipolar hemiarthroplasty; C: uncemented modern bipolar hemiarthroplasty; D: cemented modern bipolar hemiarthroplasty; E: uncemented first-generation unipolar hemiarthroplasty; F: uncemented modern unipolar hemiarthroplasty; G: total hip arthroplasty; H: dual-mobility total hip arthroplasty;I: pins; J: screws; K: non-operative treatment; L: cemented modern unipolar hemiarthroplasty

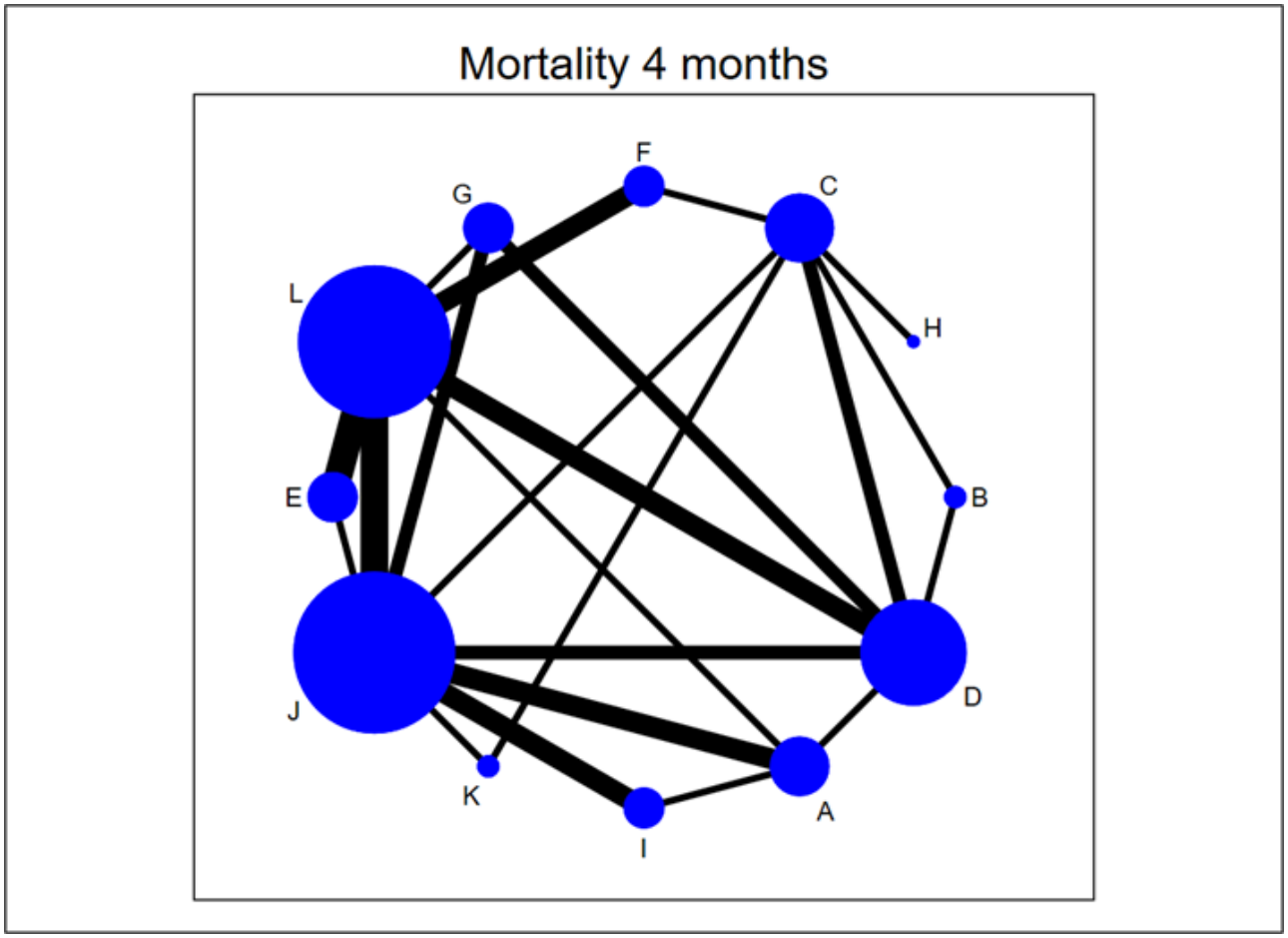


Figure 4. Network geometry for mortality at 12 months. The size of the nodes is proportional to the number of trials investigating each treatment, whilst the thickness of the edges is proportional to the number of direct comparisons. Treatment nodes - A: dynamic fixed angle plate; B: uncemented first-generation bipolar hemiarthroplasty; C: uncemented modern bipolar hemiarthroplasty; D: cemented modern bipolar hemiarthroplasty; E: uncemented first-generation unipolar hemiarthroplasty; F: uncemented modern unipolar hemiarthroplasty; G: total hip arthroplasty; H: dual-mobility total hip arthroplasty; I: pins; J: screws; K: non-operative; L: cemented modern unipolar hemiarthroplasty

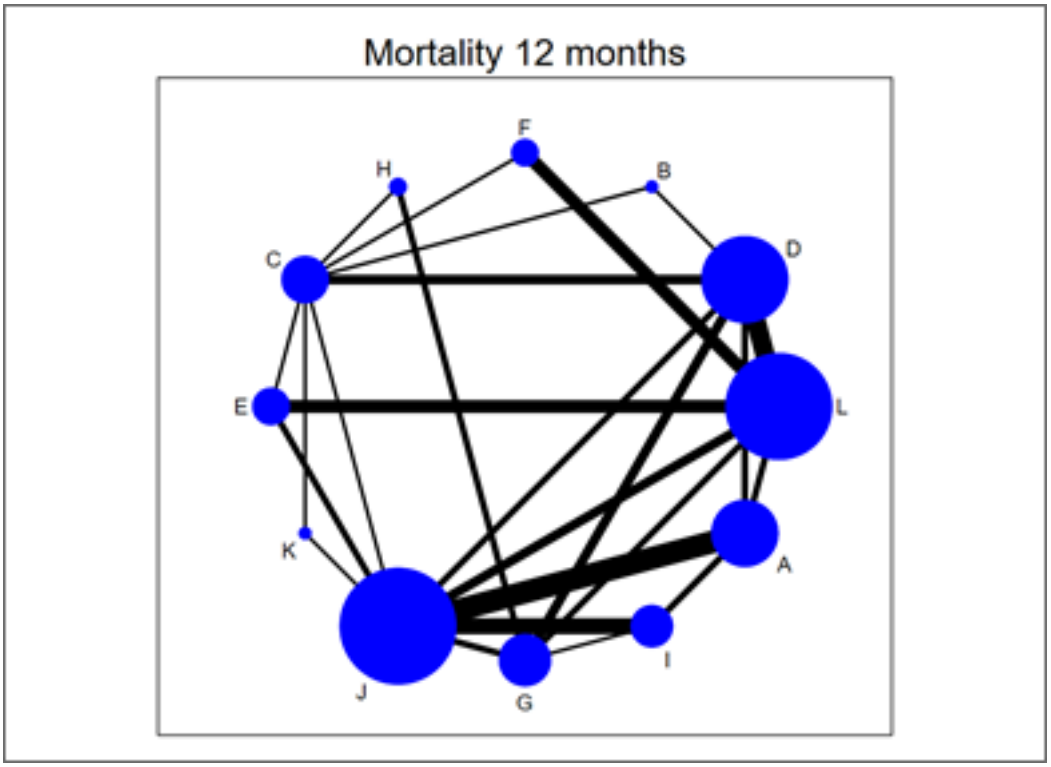


Figure 5. Network geometry for late mortality. The size of the nodes is proportional to the number of trials investigating each treatment, whilst the thickness of the edges is proportional to the number of direct comparisons. Treatment nodes - A: dynamic fixed angle plate; B: uncemented modern bipolar hemiarthroplasty; C: cemented modern bipolar hemiarthroplasty; D: uncemented first-generation unipolar hemiarthroplasty; E: total hip arthroplasty; F: screws; G: non-operative treatment; H: cemented modern unipolar hemiarthroplasty

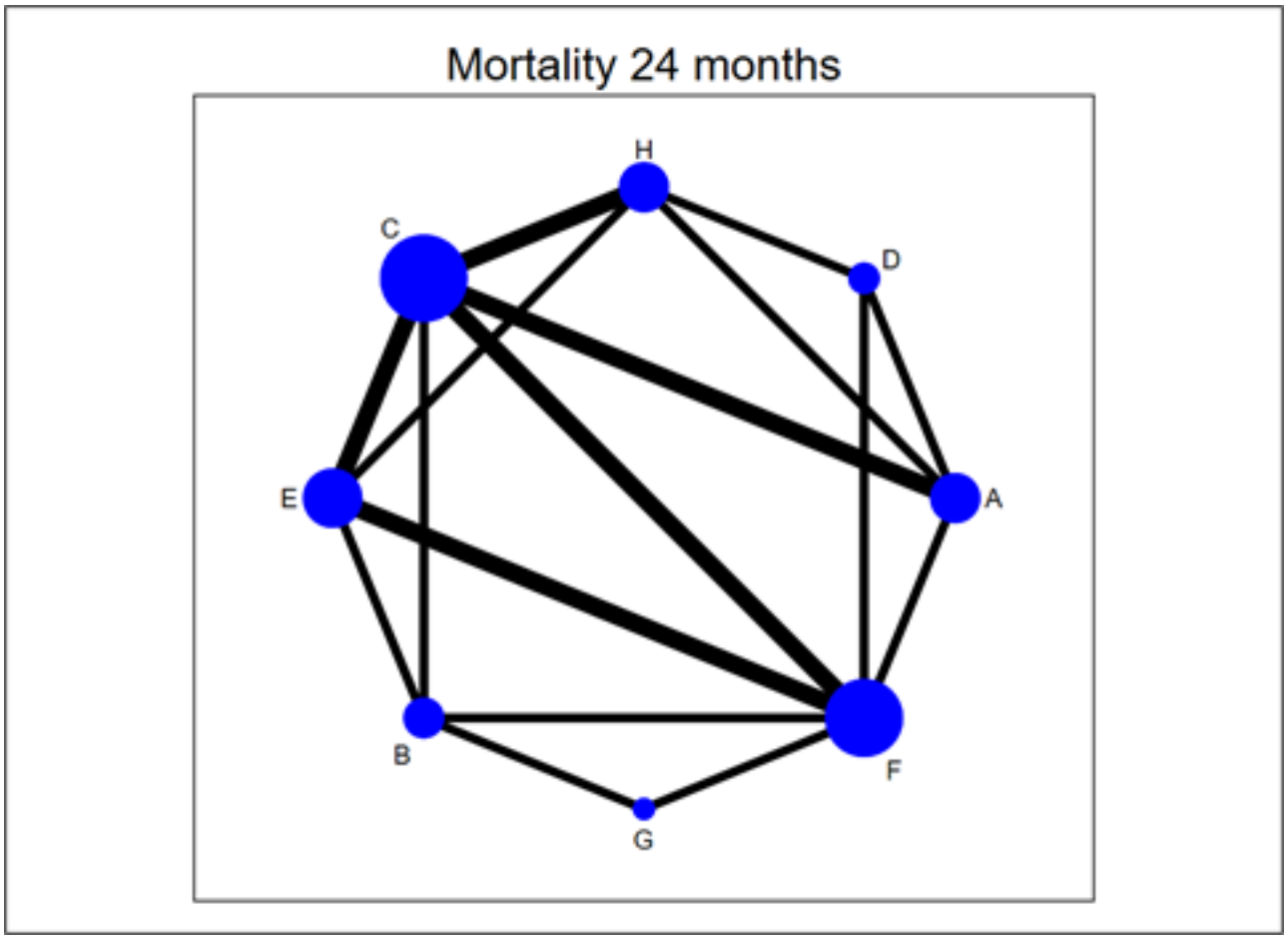


Figure 6. Network geometry for early health-related quality of life (HRQoL). The size of the nodes is proportional to the number of trials investigating each treatment, whilst the thickness of the edges is proportional to the number of direct comparisons. Treatment nodes: A: uncemented modern bipolar hemiarthroplasty; B: cemented modern bipolar hemiarthroplasty; C: uncemented modern unipolar hemiarthroplasty;D: total hip arthroplasty; E: dual-mobility total hip arthroplasty; F: screws; G: non-operative treatment; H: cemented modern unipolar hemiarthroplasty

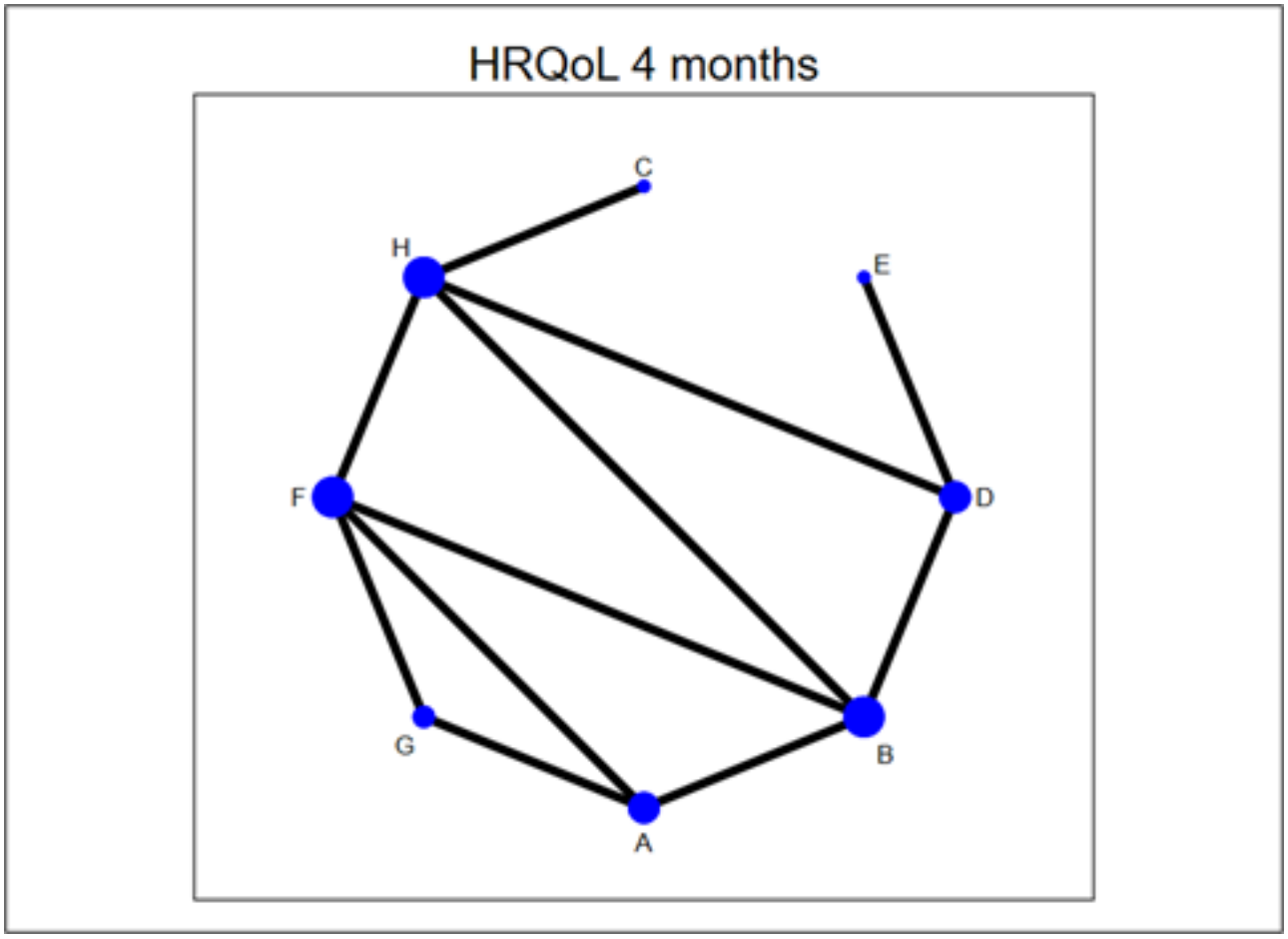


Figure 7. Network geometry for HRQoL at 12 months. The size of the nodes is proportional to the number of trials investigating each treatment, whilst the thickness of the edges is proportional to the number of direct comparisons. Treatment nodes - A: dynamic fixed angle plate;B: uncemented modern bipolar hemiarthroplasty; C: cemented modern bipolar hemiarthroplasty; D: uncemented modern unipolar hemiarthroplasty; E: total hip arthroplasty; F: screws; G: non-operative treatment; H: cemented modern unipolar hemiarthroplasty

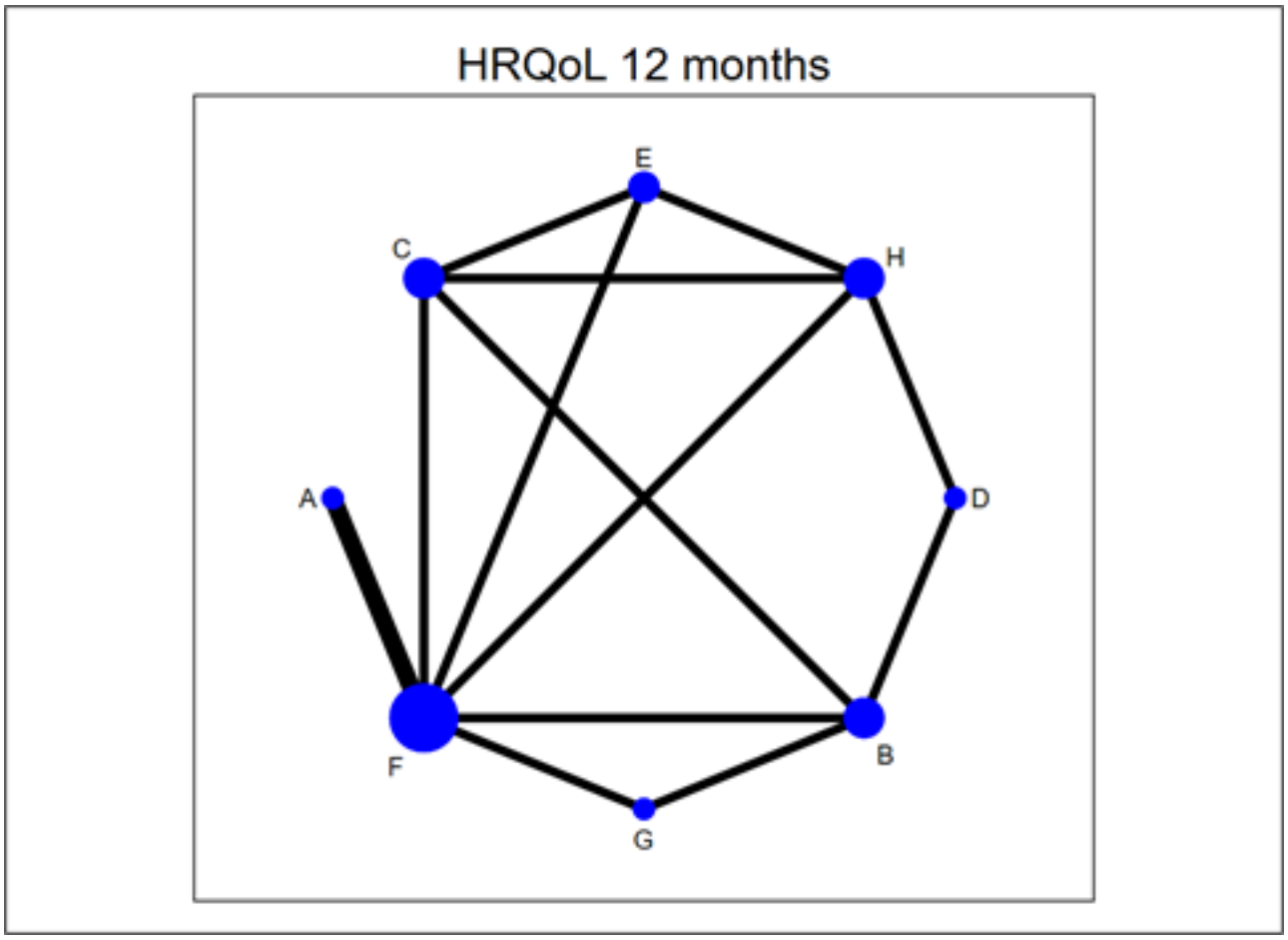


Figure 8. Network geometry for late HRQoL. The size of the nodes is proportional to the number of trials investigating each treatment, whilst the thickness of the edges is proportional to the number of direct comparisons. Treatment nodes - A: uncemented modern bipolar hemiarthroplasty; B: cemented modern bipolar hemiarthroplasty; C: uncemented modern unipolar hemiarthroplasty; D: total hip arthroplasty; E: screws; F: non-operative; G: cemented modern unipolar

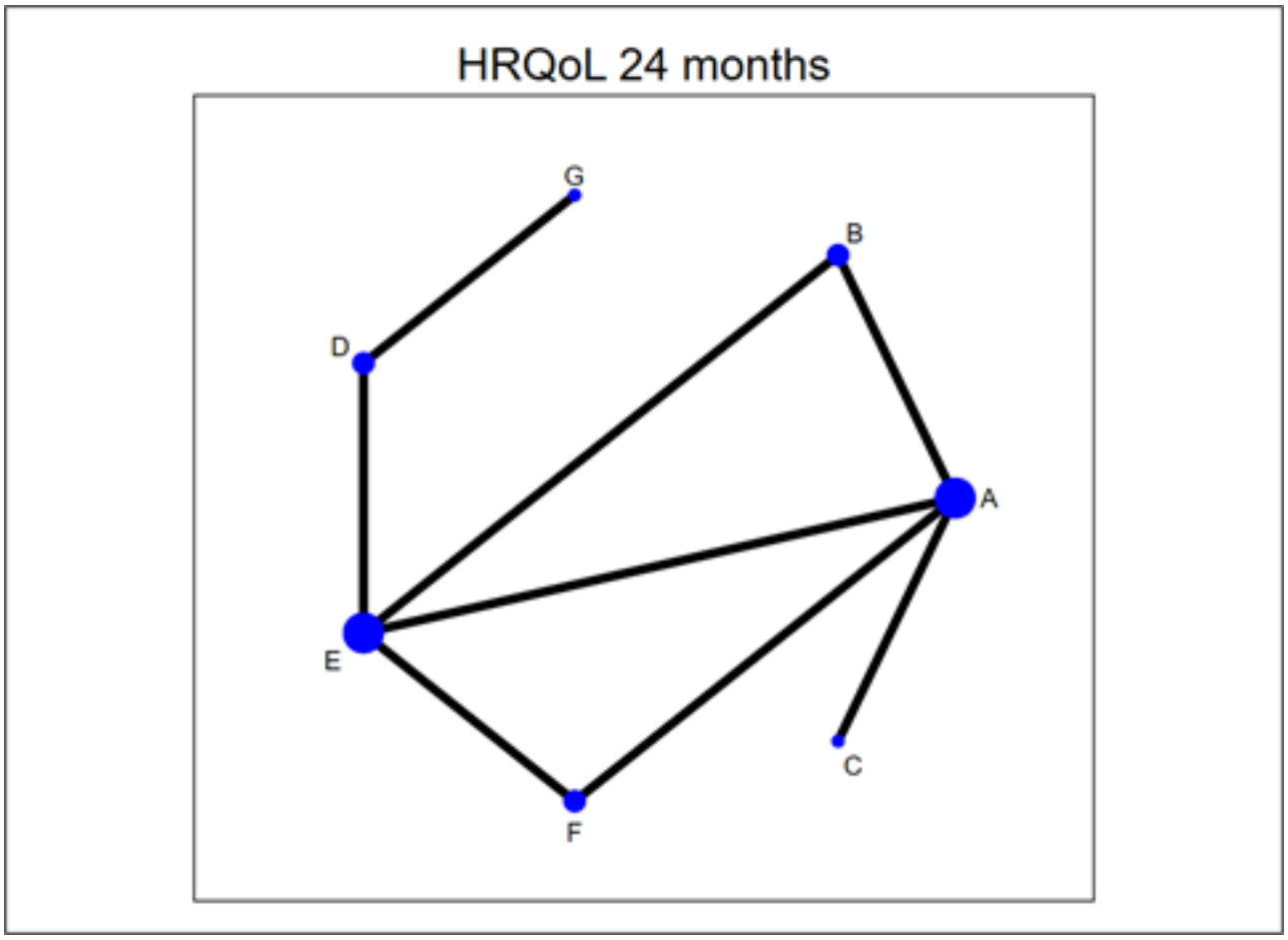
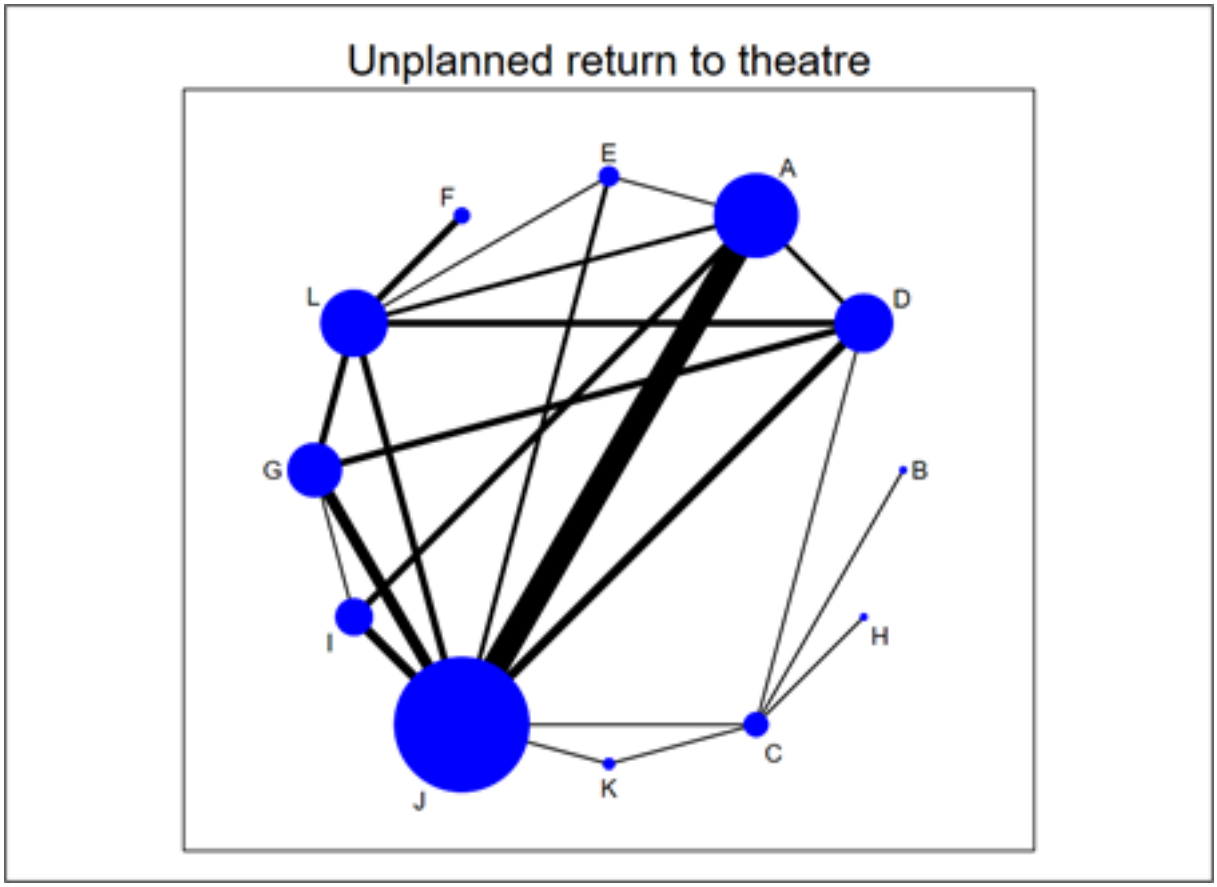


Figure 9. Network geometry for unplanned return to theatre. The size of the nodes is proportional to the number of trials investigating each treatment, whilst the thickness of the edges is proportional to the number of direct comparisons. Treatment arms - A: dynamic fixed angle plate; B: uncemented first-generation bipolar hemiarthroplasty; C: uncemented modern bipolar hemiarthroplasty;D: cemented modern bipolar hemiarthroplasty; E: uncemented first-generation unipolar hemiarthroplasty; F: uncemented modern unipolar hemiarthroplasty; G: total hip arthroplasty; H: dual-mobility total hip arthroplasty; I: pins; J: screws; K: non-operative treatment; L: cemented modern unipolar hemiarthroplasty



- mortality at 12 months (participant numbers in the nodes ranged from 51 to 1978; studies per treatment comparison ranged from 1 to 7);
- health-related quality of life (HRQoL) at 12 months (participant numbers in the nodes ranged from 51 to 846; studies per treatment comparison ranged from1 to 3);
- unplanned return to theatre (participant numbers in the nodes ranged from 51 to 2717; studies per treatment comparison ranged from 1 to 11).

We prepared summary of findings tables for these three networks, and we selected cemented modern unipolar HA as our reference comparator against which we reported network effect estimates and assessed the certainty of the evidence. This treatment was included in all networks and was deemed clinically to be a reasonable candidate as a 'default' treatment that would likely be appropriate for the vast majority of patients with an intracapsular fracture.

For each treatment in all of the networks, we calculated probabilities for each treatment for every possible rank between best and worst treatment, along with the mean rank and surface under the cumulative ranking (SUCRA) values.

We noted that one study, which compared an old design with a modern design of HA, appeared to contribute to a lack of consistency, particularly in the network for unplanned return to theatre (Ravikumar 2000). Because we suspected that this was driven by high risks of bias in this study, we decided to remove this study from all the networks. This allowed us to calculate network estimates based on a consistency model throughout. For all outcomes, other than early and late HRQoL, we used a random-effects model for these calculations. For early and late HRQoL, we performed a fixed-effect network meta-analysis instead of a random-effects model because each treatment comparison was only represented by a single study and there was a lack of heterogeneity present in these networks. The magnitude of the estimated between-study standard deviations, where applicable, for each of the networks was in keeping with published estimates of non-pharmacological interventions (Rhodes 2015; Turner 2012).

1. Early mortality

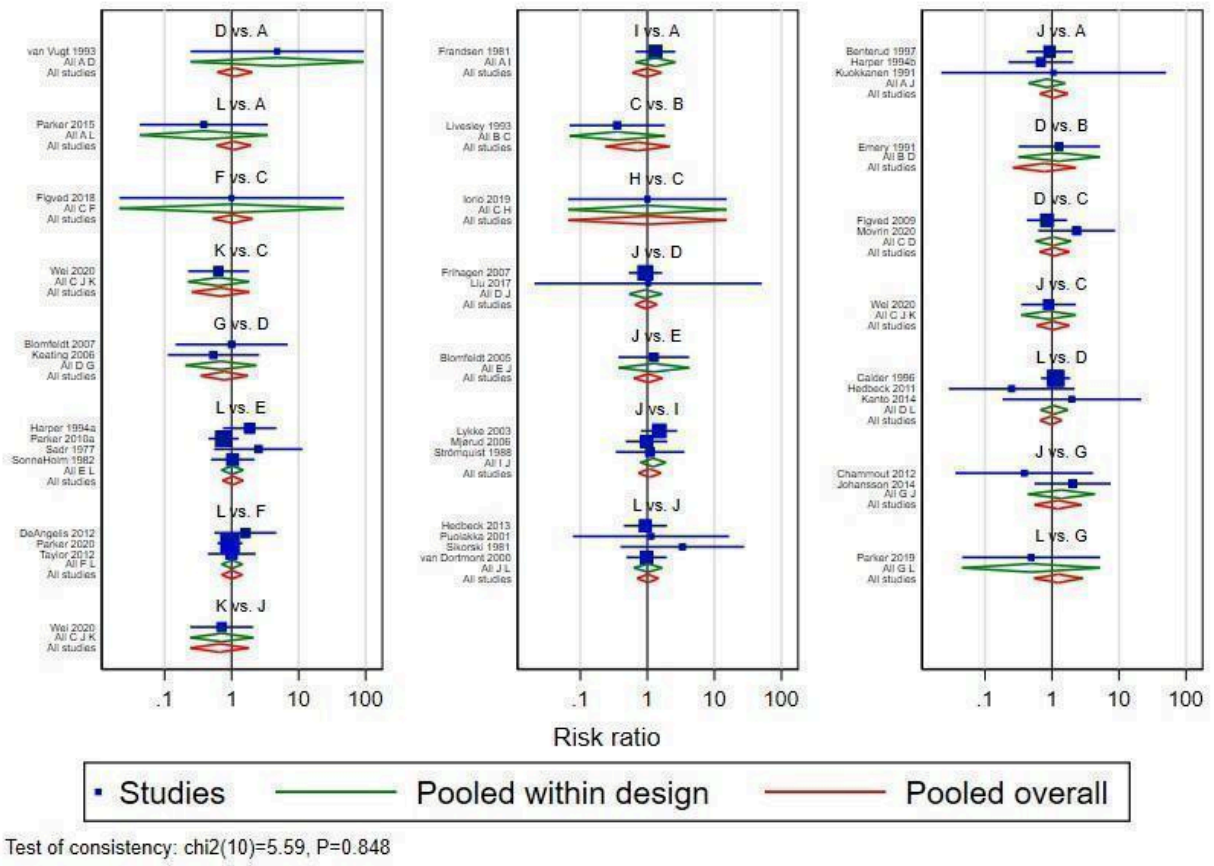
We included 38 studies (5789 randomised participants; 5617 analysed participants) in the network for mortality within four months of surgery (Benterud 1997; Blomfeldt 2005; Blomfeldt 2007; Calder 1996; Chammout 2012; DeAngelis 2012; Emery 1991; Figved 2009; Figved 2018; Frandsen 1981; Frihagen 2007; Harper 1994a; Harper 1994b; Hedbeck 2011; Hedbeck 2013; Iorio 2019; Johansson 2014; Kanto 2014; Keating 2006; Kuokkanen 1991; Liu 2017; Livesley 1993; Lykke 2003; Mjørud 2006; Movrin 2020; Parker 2010d; Parker 2015; Parker 2019; Parker 2020; Puolakka 2001; Sadr 1977; Sikorski 1981; Sonne-Holm 1982; Strömquist 1988; Taylor 2012; Van Dortmont 2000; Van Vugt 1993; Wei 2020). The maximum number of randomised participants was 400 and the minimum number was 28.

Eleven additional studies reported early mortality which we did not include in the network. We dropped six studies from the analysis because at least one of the treatments in these studies did not correspond with our node definitions (e.g. mixed group of internal fixation treatments) (Dolatowski 2019; Fernandez 2022; Rogmark 2002; Santini 2005; Sharma 2016; Soreide 1979). We dropped four studies from the analysis because they compared treatments within a node (e.g. a screw treatment with another screw treatment) (Inngul 2015; Mattsson 2006; Parker 2012; Sims 2018). We also excluded Ravikumar 2000 for the reasons previously described.

Direct comparisons

In the direct comparisons, we found no evidence of a difference between any of the treatments in early mortality (Table 2; Figure 10); on inspection of Table 2, we noted that all CIs for each estimate overlapped and there was little evidence to suggest that any one of the treatments was either substantially better or worse than the other. However, the CIs were wide, indicating substantial uncertainty.

Figure 10. Network forest plot for early mortality. The centre line of the diamond favours the treatment labelled on the same side (left or right). Treatment nodes - A: dynamic fixed angle plate; B: uncemented first-generation bipolar hemiarthroplasty; C: uncemented modern bipolar hemiarthroplasty; D: cemented modern bipolar hemiarthroplasty; E: uncemented first-generation unipolar hemiarthroplasty; F: uncemented modern unipolar hemiarthroplasty; G: total hip arthroplasty; H: dual-mobility total hip arthroplasty;I: pins; J: screws; K: non-operative treatment; L: cemented modern unipolar hemiarthroplasty



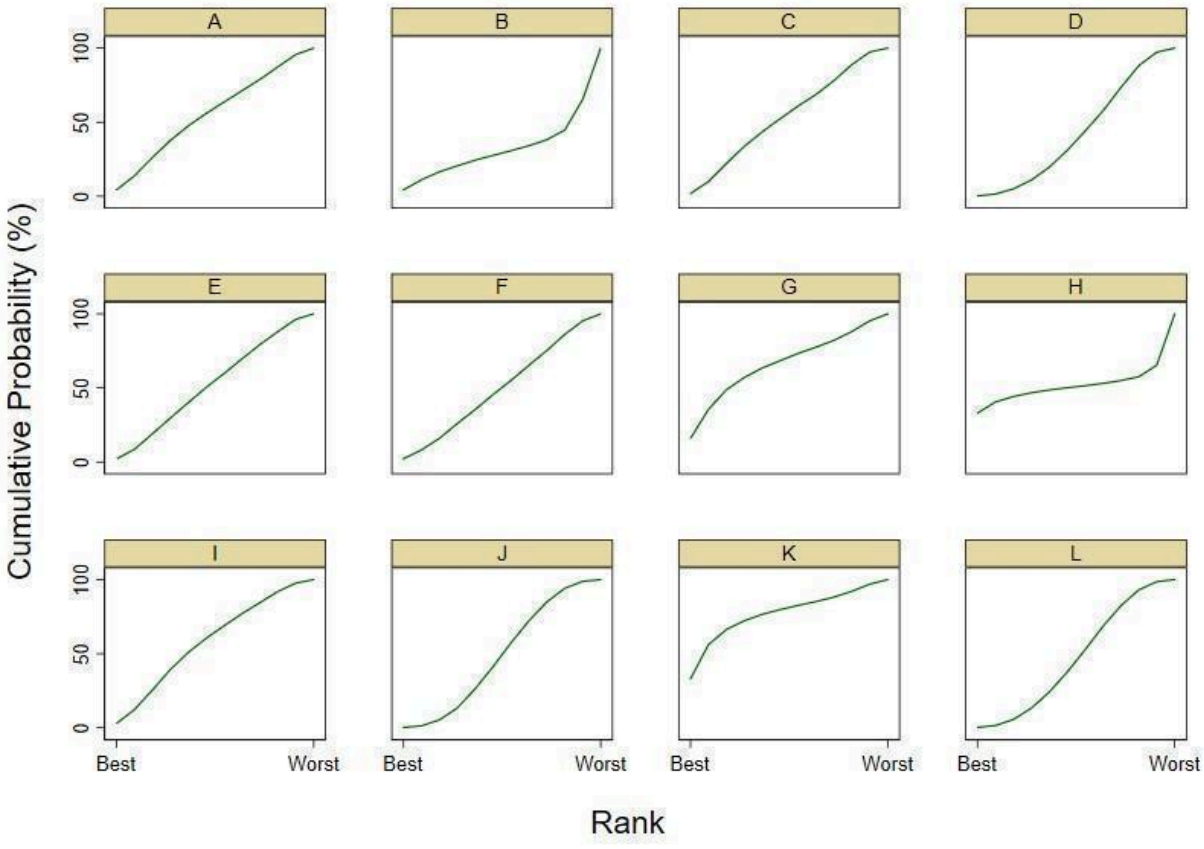
Network meta-analysis

The global test for inconsistency was nonsignificant (P = 0.846).

Whilst the proportion of female participants and the average age seemed to broadly agree within each treatment comparison, we noted some fluctuations in the proportions of participants with displaced or undisplaced fractures. It is possible that fracture displacement may affect the transitivity assumption for this network.

We found that non-operative treatment, THA (single articulation) and pins seemed to have the greatest likelihood of being ranked highly (mean ranks 3.7, 4.9, 5.9; SUCRA values 0.8, 0.6, 0.6, respectively) (Table 3; Figure 11). Non-operative treatment was ranked the highest, but we note that this was derived from one small three-arm study (Wei 2020). Uncemented first-generation bipolar HA had the worst mean rank (8.8) and the lowest SUCRA values (0.3), which would indicate that this treatment has the lowest probability of reducing early death. However, on visual inspection of the CIs in Table 2, we noted no evidence of a difference between the treatments in any of the network estimates for this outcome, and we are cautious in drawing meaningful interpretations from the ranking of treatments in this network.

Figure 11. Cumulative ranking probability curves for each treatment in the early mortality network. Each curve corresponds to the cumulative probability for all treatment ranks. From left to right along the x-axis are the possible rankings for each treatment (12 in total; only best (1st) and worst (12th) shown in Figure). Probabilities of each ranking are cumulatively summed from best to worst along the x-axis for each treatment. Treatment nodes - A: dynamic fixed angle plate; B: uncemented first-generation bipolar hemiarthroplasty; C: uncemented modern bipolar hemiarthroplasty; D: cemented modern bipolar hemiarthroplasty; E: uncemented first-generation unipolar hemiarthroplasty; F: uncemented modern unipolar hemiarthroplasty; G: total hip arthroplasty; H: dual-mobility total hip arthroplasty;I: pins; J: screws; K: non-operative treatment; L: cemented modern unipolar hemiarthroplasty



2. Mortality at 12 months

We included 56 studies (9419 randomised participants; 9040 analysed participants) in the network for 12-month mortality (Alberts 1989; Blomfeldt 2005; Blomfeldt 2007; Borris 2020; Brandfoot 2000; Calder 1996; Chammout 2019; Cornell 1998; Davison 2001; DeAngelis 2012; Elmerson 1995; Emery 1991; FAITH 2017; Figved 2009; Figved 2018; Frihagen 2007; Griffin 2014; Griffin 2016; Harper 1994a; Harper 1994b; Hedbeck 2011; Hedbeck 2013; Herngren 1992; Iorio 2019; Jeffcote 2010; Johansson 2014; Jonsson 1996; Kalland 2019; Keating 2006; Kuokkanen 1991; Livesley 1993;

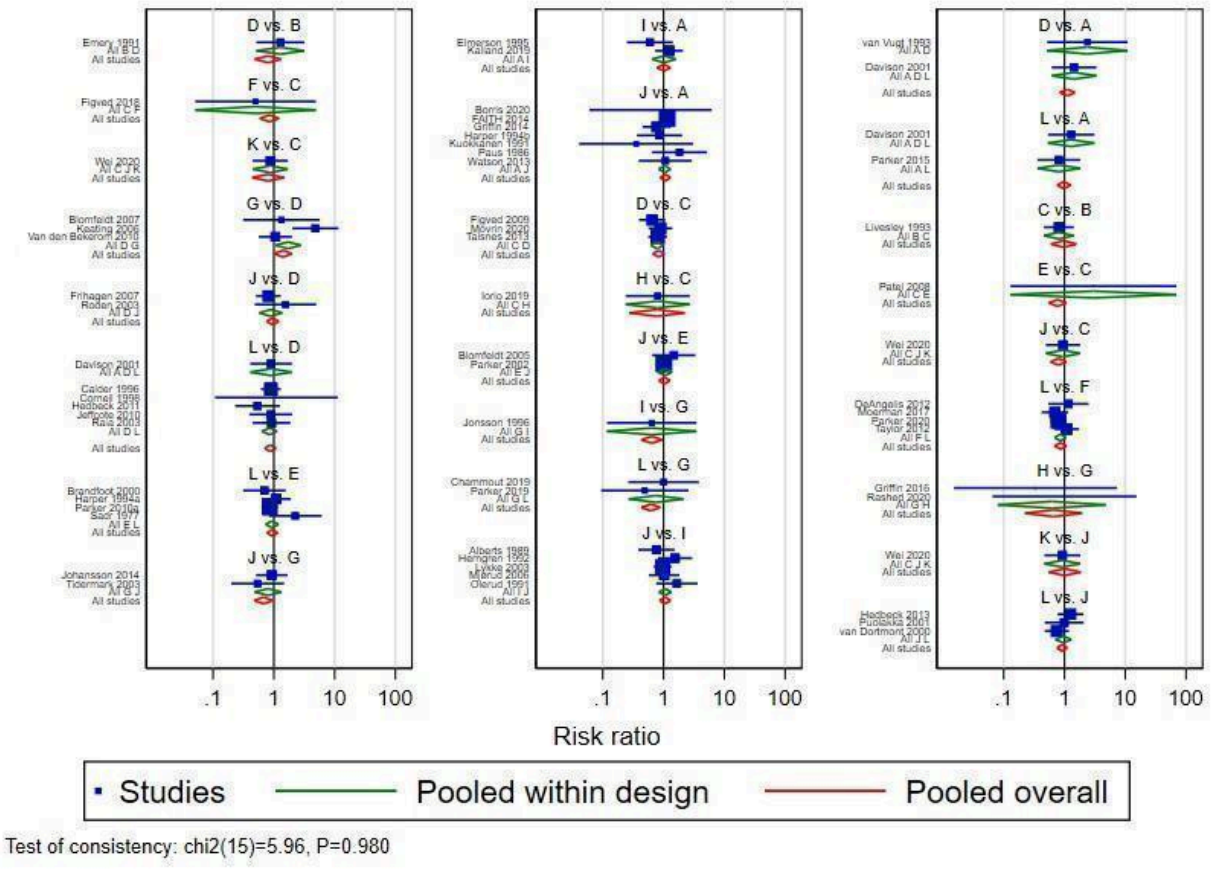
Lykke 2003; Mjørud 2006; Moerman 2017; Movrin 2020; Olerud 1991; Parker 2002; Parker 2010d; Parker 2015; Parker 2019; Parker 2020; Patel 2008; Paus 1986; Puolakka 2001; Raia 2003; Rashed 2020; Roden 2003; Sadr 1977; Talsnes 2013; Taylor 2012; Tidermark 2003; Van den Bekerom 2010; Van Dortmont 2000; Van Vugt 1993; Watson 2013; Wei 2020). The maximum number of randomised participants was 1108 and the minimum number was 21.

Twenty-six additional studies reported 12-month mortality which we did not include in the network: 13 studies were dropped from the analysis because at least one of the treatments in the study did not correspond with our node definitions (e.g. mixed group of internal fixation treatments) (Cadossi 2013; Dolatowski 2019; Fernandez 2022; HEALTH 2019; Inngul 2015; Macaulay 2008; Moroni 2002; Mouzopoulos 2008; Rogmark 2002; Santini 2005; Soreide 1979; Svenningsen 1984; Vidovic 2013; 12 studies were dropped because they compared treatments within a node (Chammout 2017; Elmerson 1988; Holmberg 1990; Kim 2012; Lim 2020; Lindequist 1989; Mattsson 2006; Parker 2010c; Parker 2012; Rehnberg 1989; Strömquist 1984; Wihlborg 1990); we also excluded Ravikumar 2000 as previously described.

Direct comparisons

In the direct comparisons, we found evidence of a difference in mortality at 12 months between the following comparisons (Table 4; Figure 12).

Figure 12. Network forest plot for 12 month mortality. The centre line of the diamond favours the treatment labelled on the same side (left or right). Treatment nodes - A: dynamic fixed angle plate; B: uncemented first-generation bipolar hemiarthroplasty; C: uncemented modern bipolar hemiarthroplasty; D: cemented modern bipolar hemiarthroplasty; E: uncemented first-generation unipolar hemiarthroplasty; F: uncemented modern unipolar hemiarthroplasty; G: total hip arthroplasty; H: dual-mobility total hip arthroplasty; I: pins; J: screws; K: non-operative; L: cemented modern unipolar hemiarthroplasty



- Uncemented modern bipolar HA versus cemented modern bipolar HA (RR 0.78, 95% CI 0.61 to < 1.00, favours cemented; 2 studies, 557 participants).
- Cemented modern bipolar HA versus THA with single articulation (RR 1.72, 95% CI 1.06 to 2.78, favours HA; 3 studies, 699 participants).

Network meta-analysis

The global test of inconsistency was non-significant (P = 0.980).

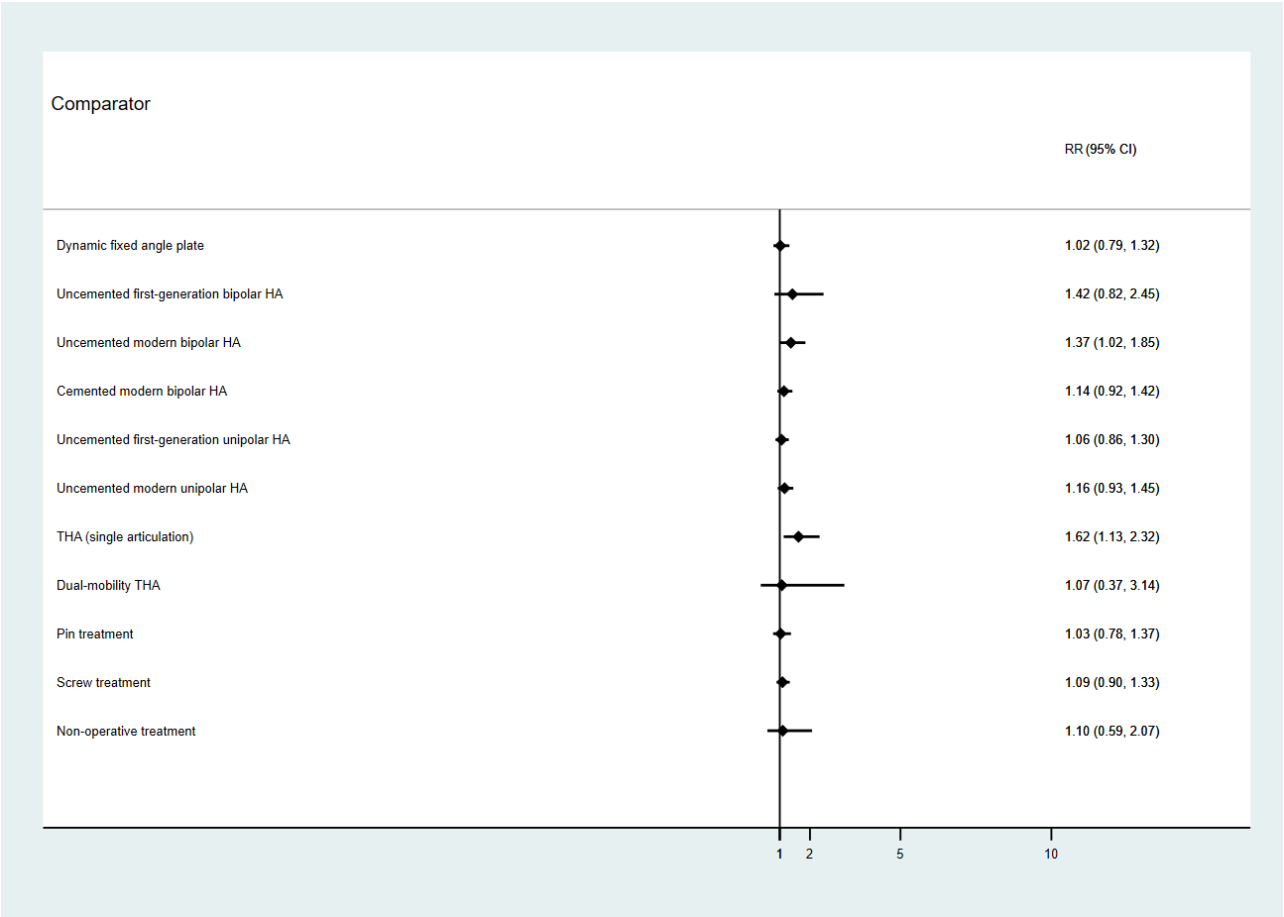
Based upon the network estimates, we noted a difference in 12-month mortality for the following comparisons.

- Dynamic fixed angle plate versus THA with single articulation (RR 1.59, 95% CI 1.08 to 2.34, favours fixed angle plate); this effect was derived from only indirect evidence.
- THA with single articulation versus pins (RR 0.64, 95% CI 0.43 to 0.95, favours pins); this effect was derived from direct evidence (RR 0.64, 95% CI 0.12 to 3.48; 1 study, 50 participants) and indirect evidence (RR 0.64, 95% CI 0.42 to 0.96).
- THA with single articulation versus screws (RR 0.68, 95% CI 0.48 to 0.95, favours screws); derived from direct evidence (RR 0.80, 95% CI 0.48 to 1.34; 2 studies, 243 participants) and indirect evidence (RR 0.59, 95% CI 0.37 to 0.93).
- Uncemented first-generation unipolar HA versus THA with single articulation (RR 1.53, 95% CI 1.04 to 2.25, favours uncemented first-generation unipolar); derived from only indirect evidence.
- Cemented modern unipolar HA versus uncemented modern bipolar HA (RR 1.37, 95% CI 1.02 to 1.85, favours cemented modern unipolar); derived only from indirect evidence.
- Cemented modern unipolar HA versus THA with single articulation (RR 1.62, 95% CI 1.13 to 2.32, favours cemented modern unipolar); this effect was derived from direct evidence (RR 1.33, 95% CI 0.47 to 3.75; 2 studies, 225 participants) and indirect evidence (RR 1.66, 95% CI 1.14 to 2.44).
- Cemented modern bipolar HA versus THA with single articulation (RR 1.42, 95% CI 1.01 to 2.00, favours cemented modern bipolar HA); this effect was derived from direct evidence (RR 1.72, 95% CI 1.06 to 2.78; 3 studies, 699 participants) and indirect evidence (RR 1.16, 95% CI 0.71 to 1.90).

There was no evidence of any difference between the treatments in the remaining comparisons in the network meta-analysis (Table 4).

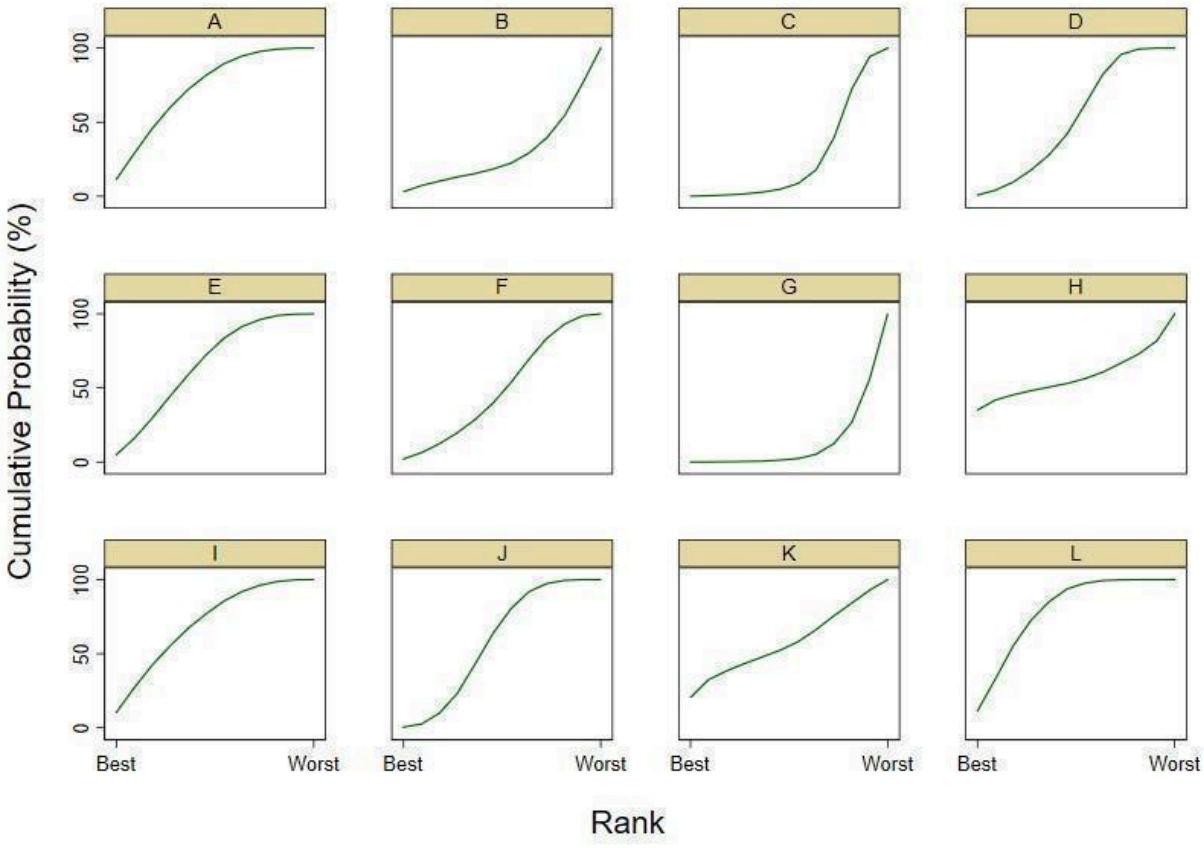
A summary of this outcome, compared to cemented modern unipolar HA, is in Summary of findings 1, and we present the network estimates against this reference comparator in Figure 13. The certainty of the evidence ranged from low to very low. We downgraded the evidence for all treatments by one level for risk of bias because all studies in the direct or indirect estimates (or both estimates) had unclear risks of bias in at least one domain. We also downgraded for a further level for risk of bias if estimates included studies at high risk of bias. We noted that gender and age were largely consistent between studies but it is possible that between-study variation in fracture displacement may affect the transitivity assumption for this network, and we downgraded some estimates when intransitivity was more apparent. There was no evidence for incoherence, but we downgraded estimates that included evidence of benefits as wells as harms for imprecision.

Figure 13. Mortality at 12 months. Network estimates for treatments compared against cemented modern unipolar HA. CI: confidence interval;HA: hemiarthroplasty; RR: risk ratios; THA: total hip arthroplasty



We found that cemented modern unipolar HA, dynamic fixed angle plate and pins seemed to have the greatest likelihood of being ranked highly (mean rank 3.5, 4.2, 4.5; SUCRA values 0.8, 0.7, 0.7, respectively). THA (single articulation) had the highest mean rank (10.9) and lowest SUCRA values (0.1) which would indicate that this treatment has the lowest probability of reducing 12-month mortality (Table 5; Figure 14). Correspondingly, on visual assessment of the network-estimated risk ratios in Figure 13, cemented modern unipolar HA (reference) and dynamic fixed angle plates and pins yielded very similar outcomes and THA (single articulation) significantly worse.

Figure 14. Cumulative ranking probability curves for each treatment in the mortality at 12 months network. Each curve corresponds to the cumulative probability for all treatment ranks. From left to right along the x-axis are the possible rankings for each treatment (12 in total; only best (1st) and worst (12th) shown in Figure). Probabilities of each ranking are cumulatively summed from best to worst along the x-axis for each treatment. Treatment nodes - A: dynamic fixed angle plate; B: uncemented first-generation bipolar hemiarthroplasty; C: uncemented bipolar hemiarthroplasty; D: cemented modern bipolar hemiarthroplasty; E: uncemented first-generation unipolar hemiarthroplasty; F: uncemented modern unipolar hemiarthroplasty; G: total hip arthroplasty; H: dual-mobility total hip arthroplasty; I: pins; J: screws; K: non-operative; L: cemented modern unipolar hemiarthroplasty



3. Late mortality

We included 17 studies (3015 randomised participants; 3009 analysed participants) in the network for late mortality (Baker 2006; Blomfeldt 2007; Chammout 2012; Davison 2001; El-Abed 2005; Figved 2009; Frihagen 2007; Kanto 2014; Parker 2002; Parker 2010d; Roden 2003; Sørensen 1992; Tidermark 2003; Van den Bekerom 2010; Van Vugt 1993; Wei 2020; Xu 2017). These studies reported mortality at least 24 months after surgery, and we used data reported at the latest time point in the study reports. The maximum number of randomised participants was 455 and the minimum number was 43.

Five additional studies reported late mortality which we did not include in the network: three studies were dropped from the analysis because at least one of the treatments in the study did not correspond with our node definitions (e.g. mixed group of internal fixation treatments) (Cadossi 2013; Macaulay 2008; Mouzopoulos 2008); one study was dropped because it compared treatments within a node (Inngul 2015); we also excluded Ravikumar 2000 as previously described.

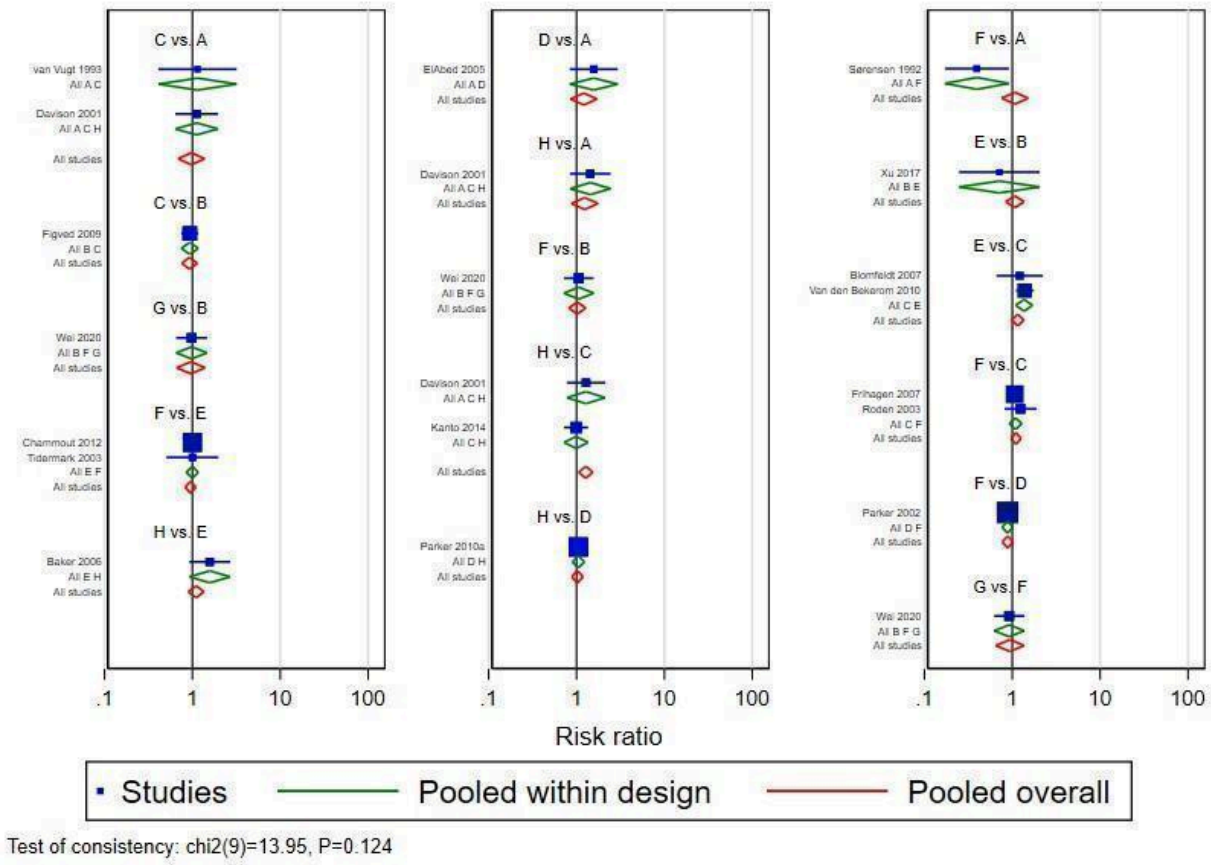
Direct comparisons

In the direct comparisons, we noted a difference in treatment for late mortality in the following comparisons.

- Dynamic fixed angle plate versus screw treatment (RR 0.39, 95% CI 0.17 to 0.91, favours screws; 1 study, 73 participants).
- Cemented modern bipolar HA versus THA with single articulation (RR 1.36, 95% CI 1.09 to 1.70, favours bipolar HA; 2 studies, 401 participants).

In the remaining treatment comparisons, we noted no evidence of a difference in late mortality (Table 6; Figure 15).

Figure 15. Network forest plot for late mortality. The centre line of the diamond favours the treatment labelled on the same side (left or right). Treatment nodes - A: dynamic fixed angle plate; B: uncemented modern bipolar hemiarthroplasty; C: cemented modern bipolar hemiarthroplasty; D: uncemented first-generation unipolar hemiarthroplasty; E: total hip arthroplasty; F: screws; G: non-operative treatment; H: cemented modern unipolar hemiarthroplasty



Network meta-analysis

The global test for inconsistency was nonsignificant (P = 0.124).

Based on the network estimates, we noted a difference in late mortality in the following comparisons.

- Uncemented first-generation unipolar HA versus cemented modern bipolar HA (RR 1.24, 95% CI 1.04 to 1.48, favours cemented modern bipolar HA); derived only from indirect evidence.
- Cemented modern unipolar HA versus cemented modern bipolar HA (RR 0.79, 95% CI 0.65 to 0.95, favours bipolar HA); derived from direct evidence (RR 0.93, 95% CI 0.71 to 1.24; 2 studies, 362 participants) and indirect evidence (RR 0.67, 95% CI 0.48 to 0.93).

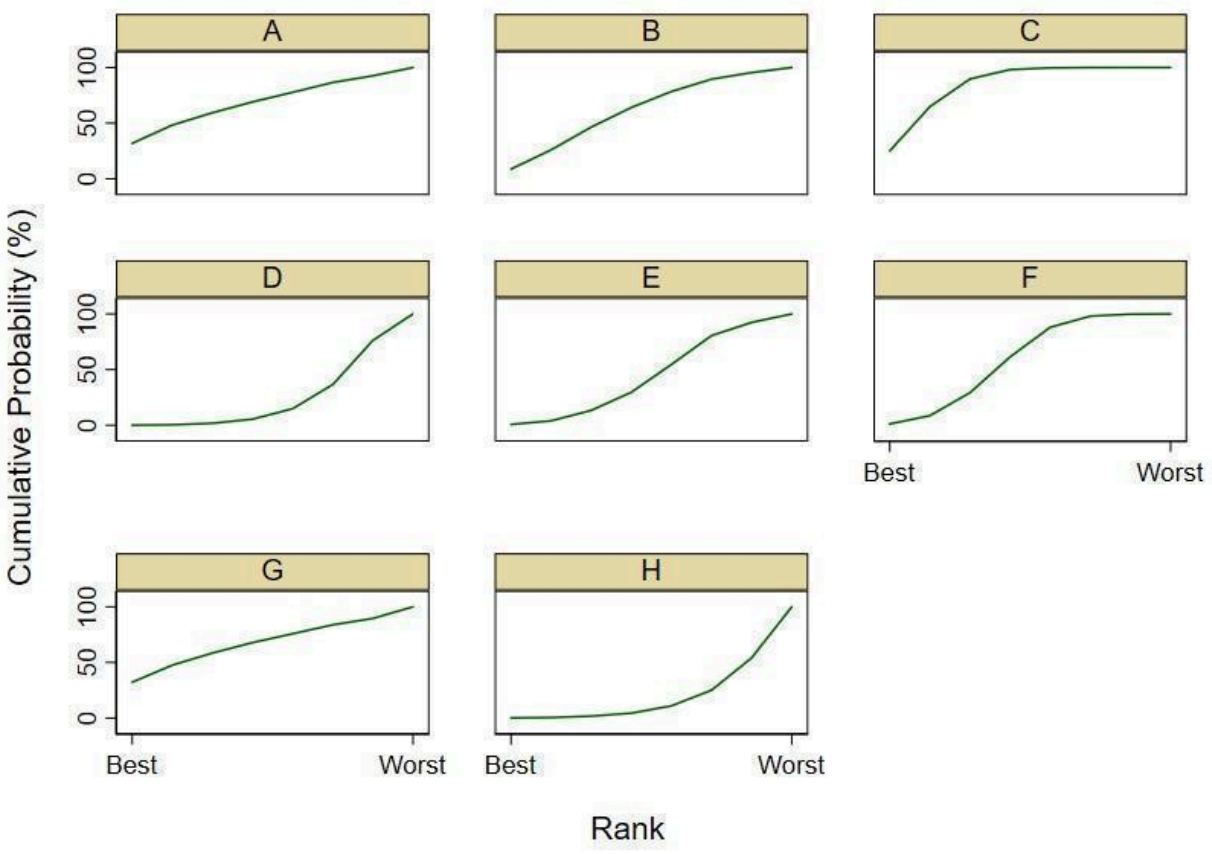
There was no evidence of any difference between the treatments in the remaining comparisons in the network meta-analysis (Table 6).

As for other networks, we noted that gender and age were largely consistent between studies, but it is possible that fracture displacement may have affected the transitivity assumption for this network.

We found that cemented modern bipolar HA, dynamic fixed angle plate and non-operative treatment seemed to have the greatest likelihood of being ranked highly (mean rank 2.2, 3.3, 3.4; SUCRA value 0.8, 0.7, 0.7, respectively); these values indicate that these

treatments have the highest probability of reduced late mortality. Uncemented first-generation unipolar hemiarthroplasty and THA (single articulation) seemed to have the lowest probability of reduced late mortality (Table 7; Figure 16). Based upon the mean ranking (6.6) and SUCRA (0.2), uncemented first-generation unipolar hemiarthroplasty also seemed to have poorer late mortality than the rest. However, there was limited evidence of differences for this outcome, reflected in small RRs and wide CIs in Table 6.

Figure 16. Cumulative ranking probability curves for each treatment in the late mortality network. Each curve corresponds to the cumulative probability for all treatment ranks. From left to right along the x-axis are the possible rankings for each treatment (8 in total; only best (1st) and worst (8th) shown in Figure). Probabilities of each ranking are cumulatively summed from best to worst along the x-axis for each treatment. Treatment nodes - A: dynamic fixed angle plate; B: uncemented modern bipolar hemiarthroplasty; C: cemented modern bipolar hemiarthroplasty; D: uncemented first-generation unipolar hemiarthroplasty; E: total hip arthroplasty; F: screws; G: non-operative treatment; H: cemented modern unipolar hemiarthroplasty



4. Early health-related quality of life (HRQoL)

We included nine studies (1419 randomised participants; 989 analysed participants) in the network for early HRQoL (Chammout 2019; Figved 2009; Frihagen 2007; Griffin 2016; Hedbeck 2011; Hedbeck 2013; Keating 2006; Moerman 2017; Wei 2020). These studies reported HRQoL up to four months after surgery. The maximum number of randomised participants was 298 and the minimum number was 21.

Four additional studies reported early HRQoL which we did not include in the network. We dropped two studies from the analysis because at least one of the treatments in these studies did not correspond with our node definitions (Dolatowski 2019; Fernandez 2022). We dropped two further studies from the analysis because they compared treatments within a node (Chammout 2017; Sims 2018).

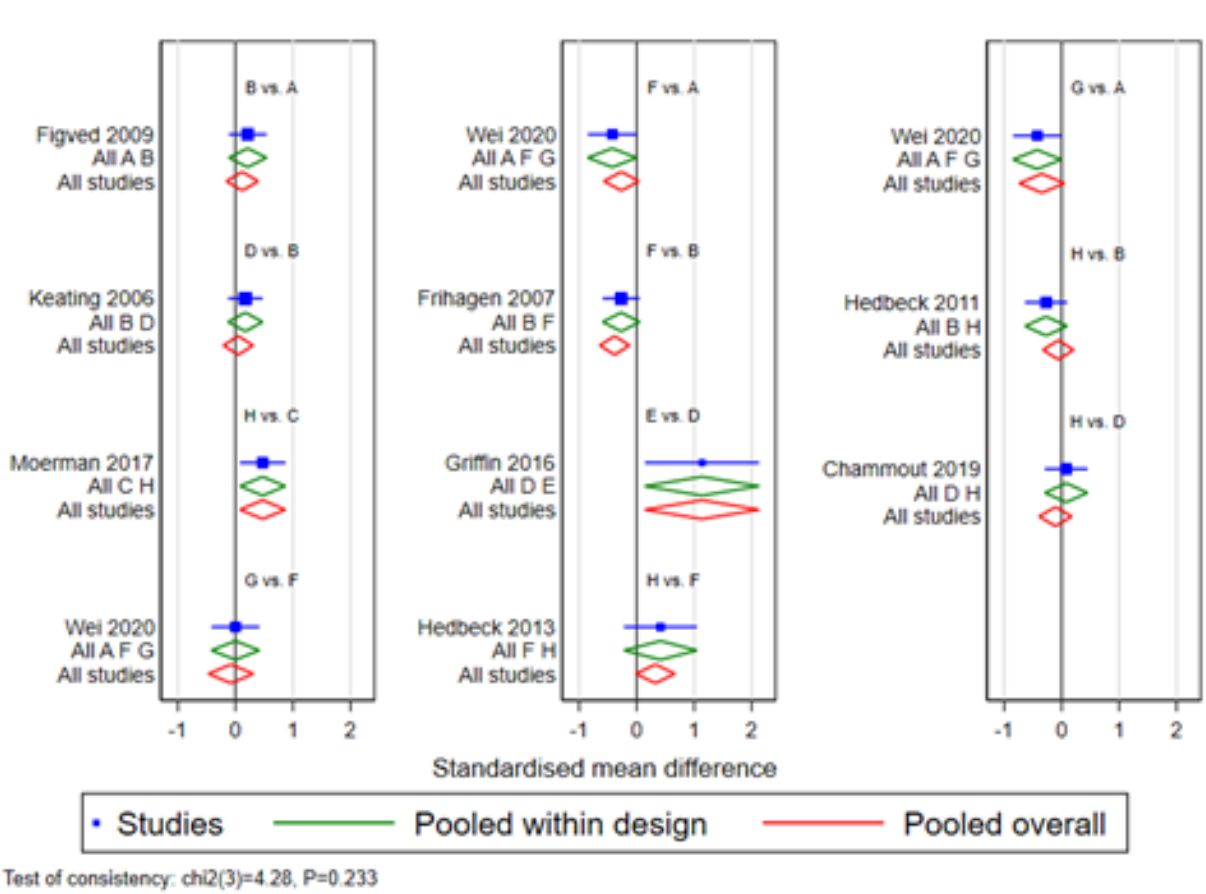
Direct comparisons

In the direct comparisons, we noted a clinically important difference in treatment for:

- THA (single articulation) versus dual-mobility THA (SMD 1.14, 95% CI 0.10 to 2.17, favours dual-mobility; 1 study, 21 participants).

In the remaining comparisons, we found no evidence of a difference between any of the treatments in early HRQoL (Table 8; Figure 17).

Figure 17. Network forest plot for early health-related quality of life (HRQoL). The centre line of the diamond favours the treatment labelled on the same side (left or right). Treatment nodes: A: uncemented modern bipolar hemiarthroplasty; B: cemented modern bipolar hemiarthroplasty; C: uncemented modern unipolar hemiarthroplasty;D: total hip arthroplasty; E: dual-mobility total hip arthroplasty; F: screws; G: non-operative treatment; H: cemented modern unipolar hemiarthroplasty



Network meta-analysis

The global test for inconsistency was nonsignificant (P = 0.233). The magnitude of the estimated between-study SD was not calculated as a fixed-effect model was used.

Based upon the network estimates in Table 8, we noted a clinically important improvement in early HRQoL for dual-mobility THA when compared against all other treatments, as follows.

- Cemented modern unipolar HA (SMD 1.24, 95% CI 0.21 to 2.28, favours dual-mobility); derived only from indirect evidence.
- Uncemented modern bipolar HA (SMD 1.30, 95% CI 0.24 to 2.36, favours dual-mobility); derived only from indirect evidence.
- Cemented modern bipolar HA (SMD 1.19, 95% CI 0.16 to 2.21, favours dual-mobility); derived only from indirect evidence.
- Uncemented modern unipolar HA (SMD 1.72, 95% CI 0.61 to 2.82, favours dual-mobility); derived only from indirect evidence.
- THA with single articulation (SMD 1.14, 95% CI 0.15 to 2.13, favours dual-mobility); derived from direct evidence as above, and indirect evidence (SMD 0.13, 95% CI -124.10 to 123.83).
- Screw treatment (SMD -1.57, 95% CI -2.62 to -0.53, favours dual-mobility); derived only from indirect evidence.
- Non-operative treatment (SMD -1.65, 95% CI -2.75 to -0.55, favours dual-mobility); derived only from indirect evidence.

We noted a clinically important improvement in early HRQoL for cemented modern bipolar HA when compared against the following treatments.

- Uncemented modern unipolar HA (SMD -0.53, 95% CI -1.01 to -0.05, favours cemented modern bipolar HA); derived only from indirect evidence.
- Screw treatment (SMD -0.38, 95% CI -0.64 to -0.13, favours cemented modern bipolar HA); derived from direct evidence (SMD -0.27, 95% CI -0.71 to 0.17; 1 study, 103 participants) and indirect evidence (SMD -0.58, 95% CI -1.10 to -0.06).
- Non-operative treatment (SMD -0.46, 95% CI -0.89 to -0.04, favours cemented modern bipolar HA); derived only from indirect evidence.

We noted a clinically important improvement in early HRQoL for cemented modern unipolar HA when compared against the following treatment.

- Uncemented modern unipolar HA (SMD -0.47, 95% CI -0.87 to -0.08, favours cemented unipolar HA); derived only from indirect evidence.

We noted a clinically important improvement in early HRQoL for THA (single articulation) when compared against the following treatments.

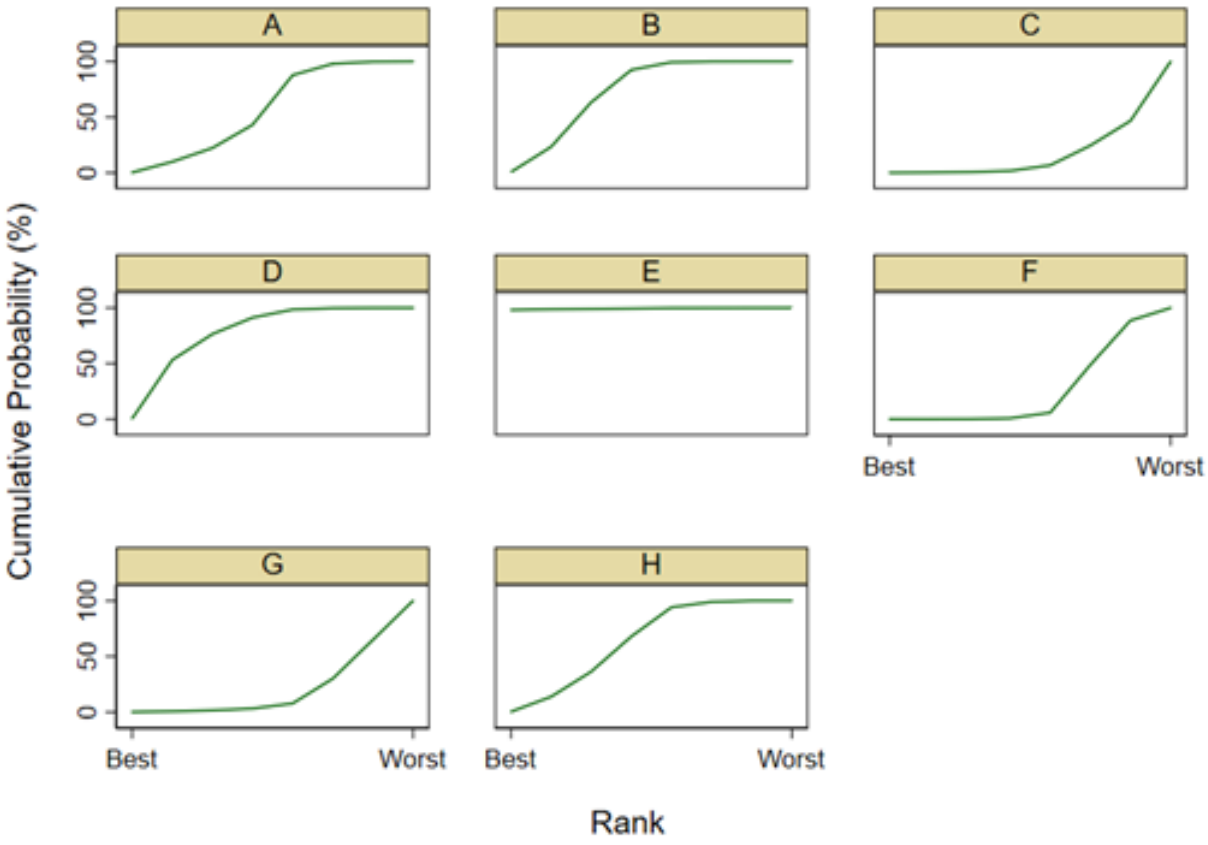
- Uncemented modern unipolar HA (SMD 0.58, 95% CI 0.09 to 1.07, favours THA with single articulation); derived only from indirect evidence.
- Screw treatment (SMD -0.43, 95% CI -0.78 to -0.08, favours THA); derived only from indirect evidence.
- Non-operative treatment (SMD -0.51, 95% CI -1.00 to -0.02, favours THA); derived only from indirect evidence.

There was no evidence of any difference between the treatments in the remaining comparisons in the network meta-analysis (Table 8; Figure 17).

Fracture displacement, the gender ratio and mean age of participants in the included studies were largely comparable and we believed the transitivity assumption held for this network.

We found that dual-mobility THA, THA (single articulation) and cemented modern bipolar HA seemed to have the greatest likelihood of being ranked highly (mean rank 1.0, 2.8, 3.2; SUCRA value 1.0, 0.7, 0.7, respectively), indicating that these treatments have very high probability of improving HRQoL within four months of treatment. The worst ranked treatments in this network were uncemented modern unipolar HA, non-operative treatment and screw treatment (Table 9; Figure 18). The other treatments were somewhat similar.

Figure 18. Cumulative ranking probability curves for each treatment in the early HRQoL network. Each curve corresponds to the cumulative probability for all treatment ranks. From left to right along the x-axis are the possible rankings for each treatment (8 in total; only best (1st) and worst (8th) shown in Figure). Probabilities of each ranking are cumulatively summed from best to worst along the x-axis for each treatment. Treatment nodes: A: uncemented modern bipolar hemiarthroplasty; B: cemented modern bipolar hemiarthroplasty; C: uncemented modern unipolar hemiarthroplasty;D: total hip arthroplasty; E: dual-mobility total hip arthroplasty; F: screws; G: non-operative treatment; H: cemented modern unipolar hemiarthroplasty



5. HRQoL at 12 months

We included 13 studies (2744 randomised participants; 1515 analysed participants) in the network for HRQoL measured at 12 months after surgery (Borris 2020; Chammout 2019; FAITH 2017; Figved 2009; Figved 2018; Frihagen 2007; Hedbeck 2011; Hedbeck 2013; Keating 2006; Moerman 2017; Tidermark 2003; Watson 2013; Wei 2020). The maximum number of randomised participants was 1108 and the minimum number was 28.

Six additional studies reported HRQoL at 12 months which we did not include in the network: five studies were dropped from the analysis because at least one of the treatments in the study did not correspond with our node definitions (Dolatowski 2019; Fernandez 2022; HEALTH 2019; Macaulay 2008; Moroni 2002), and one study was dropped because it compared treatments within a node (Chammout 2017).

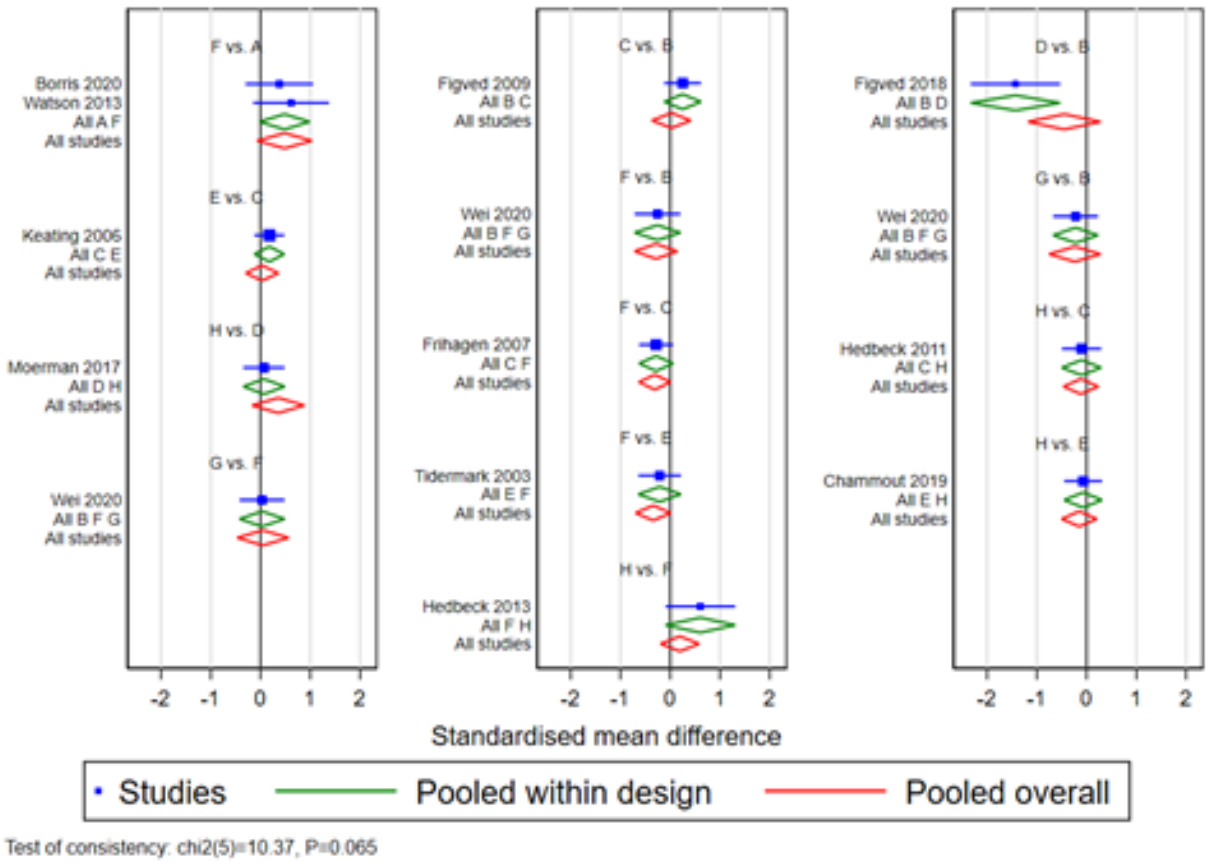
Direct comparisons

In the direct comparisons, we noted a clinically important difference in treatment for:

- uncemented modern bipolar HA versus uncemented modern unipolar HA (SMD -1.43, 95% CI -2.33 to -0.53, favours bipolar; 1 study, 28 participants).

In the remaining comparisons, we found no evidence of a difference between any of the treatments in HRQoL at 12 months (Table 10; Figure 19).

Figure 19. Network forest plot for HRQoL at 12 months. The centre line of the diamond favours the treatment labelled on the same side (left or right). Treatment nodes - A: dynamic fixed angle plate;B: uncemented modern bipolar hemiarthroplasty; C: cemented modern bipolar hemiarthroplasty; D: uncemented modern unipolar hemiarthroplasty; E: total hip arthroplasty; F: screws; G: non-operative treatment; H: cemented modern unipolar hemiarthroplasty



Network meta-analysis

The global test for inconsistency was nonsignificant (P = 0.065).

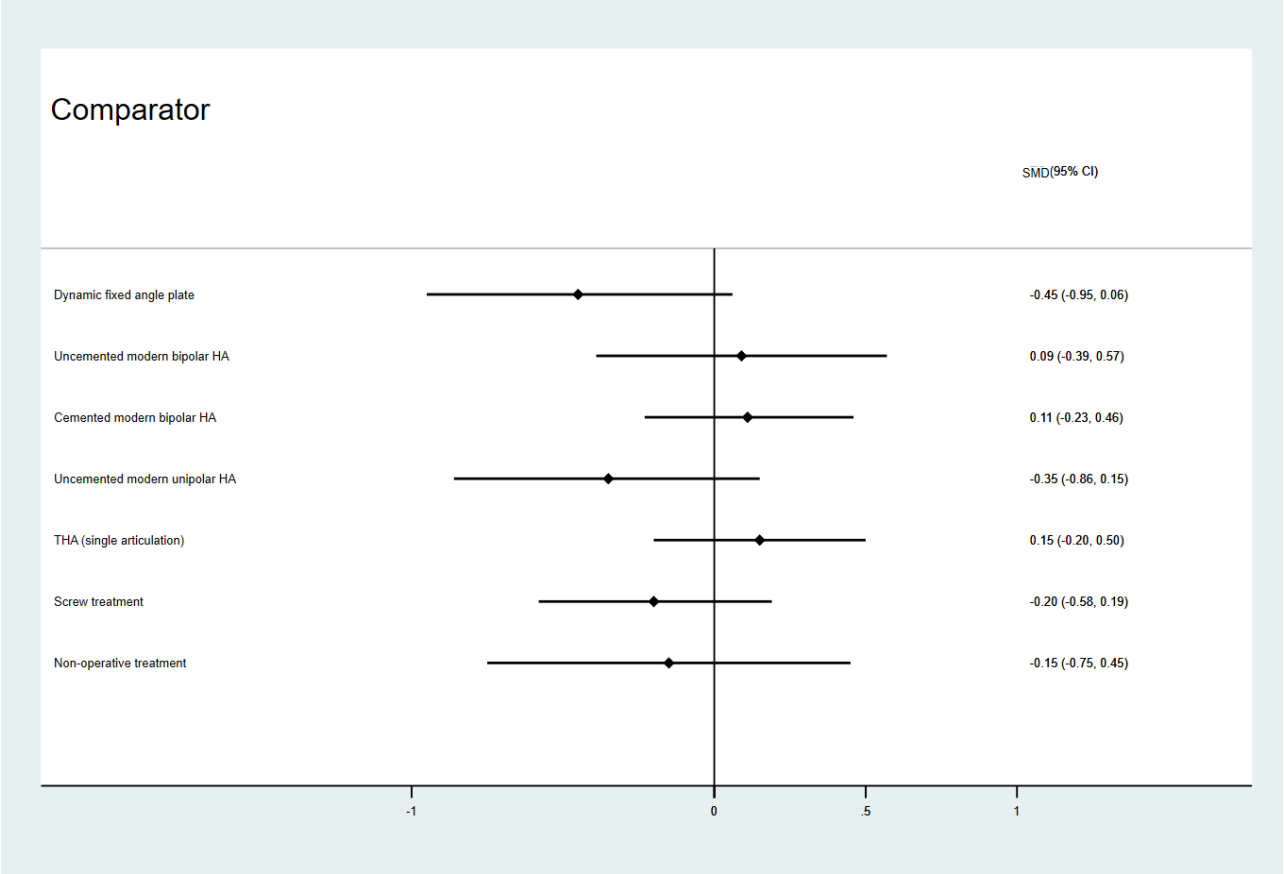
Based on the network estimates in Table 11, we noted a clinically important improvement in HRQoL in the following comparisons.

- Dynamic fixed angle plate versus cemented modern bipolar HA (SMD 0.56, 95% CI 0.08 to 1.05, favours cemented modern bipolar HA); derived only from indirect evidence.
- Dynamic fixed angle plate versus THA with single articulation (SMD 0.59, 95% CI 0.11 to 1.07, favours THA); derived only from indirect evidence.

In the remaining comparisons, we found no evidence of a difference between any of the treatments in HRQoL at 12 months (Table 10).

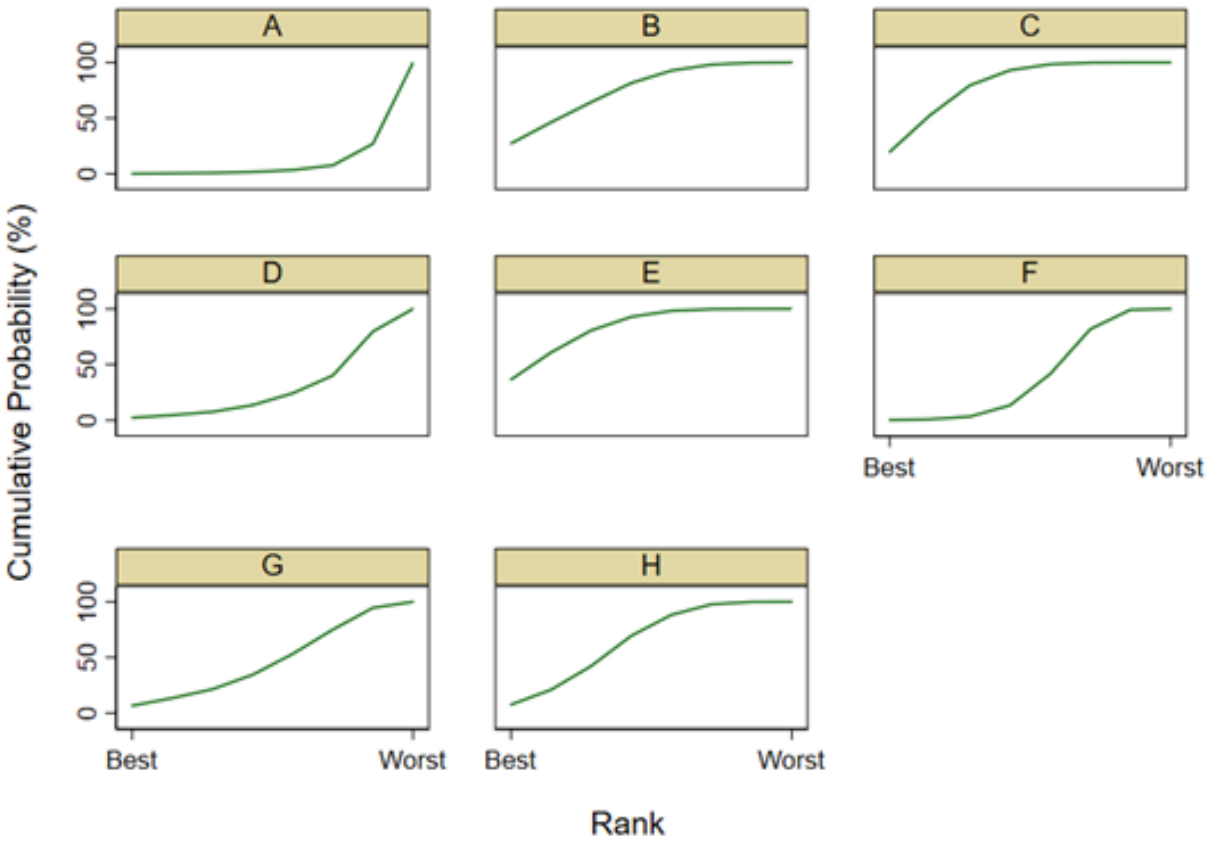
A summary of this outcome, compared to cemented modern unipolar HA, is in Summary of findings 2, and we present the network estimates against this reference comparator in Figure 20. The certainty of the evidence for all treatments was very low. We downgraded the evidence for all treatments by one level for risk of bias because all studies in the direct or indirect estimates (or both estimates) had unclear risks of bias in at least one domain. We also downgraded a further level for risk of bias if estimates included studies at high risk of selection bias, attrition bias or 'other bias'. We noted that gender and age were largely consistent between studies, but it is possible that fracture displacement may affect the transitivity assumption for this network, and we downgraded the evidence for intransitivity for dynamic fixed angle plates. We noted evidence of incoherence from a side-split investigation for uncemented modern unipolar hemiarthroplasty, and we downgraded all estimates for imprecision because these included the possibility of benefits as well as harms.

Figure 20. Health-related quality of life at 12 months. Network estimates for treatments compared against cemented modern unipolar HA. CI: confidence interval;HA: hemiarthroplasty; SMD: standardised mean difference; THA: total hip arthroplasty



We found that THA with single articulation, cemented modern bipolar HA and uncemented modern bipolar HA seemed to have the greatest likelihood of being ranked highly (mean rank 2.3, 2.6, 2.9; SUCRA value 0.8, 0.8, 0.7, respectively), indicating that these treatments have a very high probability of improving HRQoL within 12 months of treatment. The worst ranked treatments in this network were dynamic fixed angle plate (mean rank 7.6; SUCRA 0.1) and uncemented modern unipolar HA (mean rank 6.3; SUCRA 0.2) (Table 12; Figure 21). Visual inspection of the summary of the network estimated RRs in Figure 20 also suggest worse HRQoL with dynamic fixed angle plate and uncemented modern unipolar HA. There was little evidence to suggest much difference between the other treatments.

Figure 21. Cumulative ranking probability curves for each treatment in the HRQoL at 12 months network. Each curve corresponds to the cumulative probability for all treatment ranks. From left to right along the x-axis are the possible rankings for each treatment (8 in total; only best (1st) and worst (8th) shown in Figure). Probabilities of each ranking are cumulatively summed from best to worst along the x-axis for each treatment. Treatment nodes - A: dynamic fixed angle plate;B: uncemented modern bipolar hemiarthroplasty; C: cemented modern bipolar hemiarthroplasty; D: uncemented modern unipolar hemiarthroplasty; E: total hip arthroplasty; F: screws; G: non-operative treatment; H: cemented modern unipolar hemiarthroplasty



6. Late HRQoL

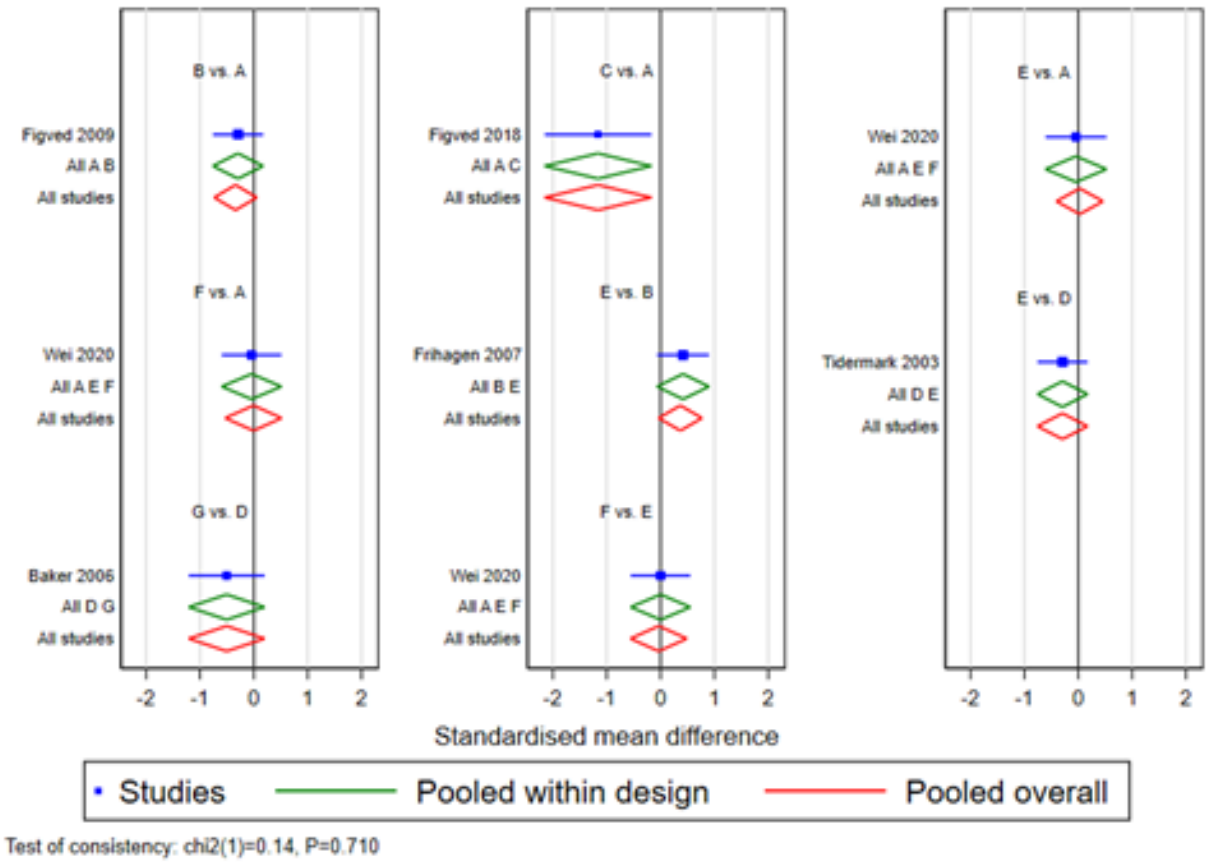
We included six studies (818 randomised participants; 338 analysed participants) in the network for late HRQoL (Baker 2006; Figved 2009; Figved 2018; Frihagen 2007; Tidermark 2003; Wei 2020). These studies reported HRQoL at least 24 months after surgery, and we used data reported at the latest time point in the study reports. The maximum number of randomised participants was 223 and the minimum number was 28.

All studies that reported late HRQoL were included in the network.

Direct comparisons

In the direct comparisons, we found no evidence of a difference between any of the treatments in late HRQoL (Table 11; Figure 22).

Figure 22. Network forest plots for late HRQoL. Treatment nodes - A: uncemented modern bipolar hemiarthroplasty; B: cemented modern bipolar hemiarthroplasty; C: uncemented modern unipolar hemiarthroplasty; D: total hip arthroplasty; E: screws; F: non-operative; G: cemented modern unipolar



Network meta-analysis

The global test for inconsistency was non-significant (P = 0.710). The magnitude of the estimated between-study SD was not calculated, as a fixed-effect model was used. Based on the network estimates in Table 11, we noted a clinically important improvement in late HRQoL in the following comparisons.

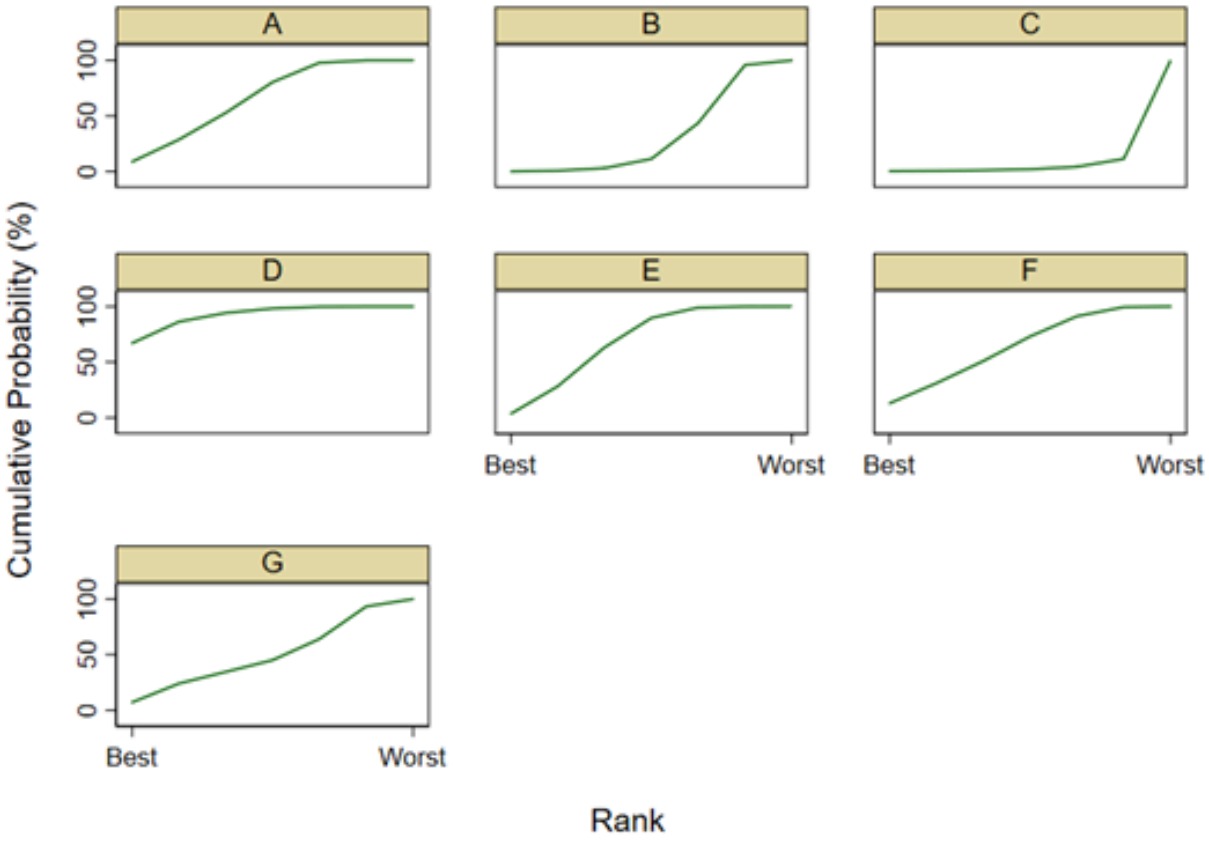
- Uncemented modern bipolar HA versus uncemented modern unipolar HA (SMD -1.16, 95% CI -2.15 to -1.17, favours uncemented modern bipolar HA); derived from direct evidence (SMD -1.16, 95% CI 1.11 to -3.42; 1 study, 28 participants) and indirect evidence (SMD -0.43, 95% CI -1.27 to 0.41).
- Cemented modern bipolar HA versus THA with single articulation (SMD 0.66, 95% CI 0.05 to 1.28, favours THA); derived from only indirect evidence.
- Uncemented modern unipolar HA verus THA (SMD 1.48, 95% CI 0.30 to 2.66, favours THA); derived from only indirect evidence.
- Uncemented modern unipolar HA versus screw treatment (SMD 1.19, 95% CI 0.11 to 2.27, favours screw treatment); derived from only indirect evidence.
- Uncemented modern unipolar HA versus non-operative treatment (SMD 1.15, 95% CI 0.03 to 2.27, favours non-operative treatment); derived from only indirect evidence.

In the remaining comparisons, we found no evidence of a difference between any of the treatments in late HRQoL (Table 11).

Fracture displacement, the gender ratio and mean age of participants in the included studies were largely comparable and we believed the transitivity assumption held for this network.

We found that THA with single articulation had the lowest mean rank (1.5) and the highest SUCRA value (0.9), indicating that this treatment has a high probability of improving HRQoL at least 24 months after treatment. The highest-ranking treatment in this network was uncemented modern unipolar HA (mean rank 6.8; SUCRA < 0.1) indicating that this treatment has the lowest probability of improving late HRQoL (Table 13; Figure 23).

Figure 23. Cumulative ranking probability curves for each treatment in the late HRQoL network. Each curve corresponds to the cumulative probability for all treatment ranks. From left to right along the x-axis are the possible rankings for each treatment (7 in total; only best (1st) and worst (7th) shown in Figure). Probabilities of each ranking are cumulatively summed from best to worst along the x-axis for each treatment. Treatment nodes - A: uncemented modern bipolar hemiarthroplasty; B: cemented modern bipolar hemiarthroplasty; C: uncemented modern unipolar hemiarthroplasty; D: total hip arthroplasty; E: screws; F: non-operative; G: cemented modern unipolar



7. Unplanned return to theatre

We included 53 studies (9493 randomised participants; 8814 analysed participants) in the network for unplanned return to theatre (Baker 2006; Benterud 1997; Blomfeldt 2005; Borris 2020; Cao 2014; Chammout 2012; Chammout 2019; Christie 1988; Davison 2001; DeAngelis 2012; Dorr 1986; El-Abed 2005; Elmerson 1995; FAITH 2017; Figved 2009; Frihagen 2007; Griffin 2014; Harper 1994a; Hedbeck 2011; Hedbeck 2013; Herngren 1992; Iorio 2019; Johansson 2014; Jonsson 1996; Kalland 2019; Kanto 2014; Keating 2006; Kuokkanen 1991; Liu 2017; Livesley 1993; Lu 2017; Lykke 2003; Madsen 1987; Mjørud 2006; Moerman 2017; Motififard 2010; Ovesen 1997; Parker 2002; Parker 2010d; Parker 2015; Parker 2019; Paus 1986; Puolakka 2001; Roden 2003; Sikorski 1981; Strömquist 1988; Sørensen 1992; Taylor 2012; Tidermark 2003; Van den Bekerom 2010; Van Vugt 1993; Watson 2013; Wei 2020). The maximum number of randomised participants was 1108 and the minimum number was 32.

Twenty-three additional studies reported data for this outcome which we did not include in the network. We dropped eight studies from the analysis because at least one of the treatments in these studies did not correspond with our node definitions (Abdelkhalek 2011; Dolatowski 2019; Fernandez 2022; HEALTH 2019; Mouzopoulos 2008; Rogmark 2002; Soreide 1979; Svenningsen 1984). We dropped 15 studies from the analysis because they compared treatments within a node (Alho 1998; Chammout 2017; Dalen 1985; Eschler 2014; Ingwersen 1992; Inngul 2015; Lagerby 1998; Lindequist 1989; Mattsson 2006; Nordkild 1985; Parker 2010c; Parker 2012; Sernbo 1990; Sims 2018; Strömquist 1988). We also excluded Ravikumar 2000 for the reasons previously described.

Direct comparisons

From visual inspection of the estimates in Table 14, we noted more unplanned returns to theatre when screw treatment was used compared to the following treatments.

- Cemented modern unipolar HA (RR 4.01, 95% CI 1.92 to 8.39, favours cemented modern unipolar; 3 studies, 310 participants).
- Cemented modern bipolar HA (RR 4.35, 95% CI 2.67 to 7.07, favours cemented modern bipolar; 4 studies, 553 participants).

- Uncemented first-generation unipolar HA (RR 5.85, 95% CI 3.47 to 9.87, favours uncemented first-generation unipolar; 2 studies, 515 participants).
- THA with single articulation (RR 3.11, 95% CI 2.23 to 4.35, favours THA; 5 studies, 718 participants).

We also noted more returns to theatre when a dynamic fixed angle plate was used compared to the following.

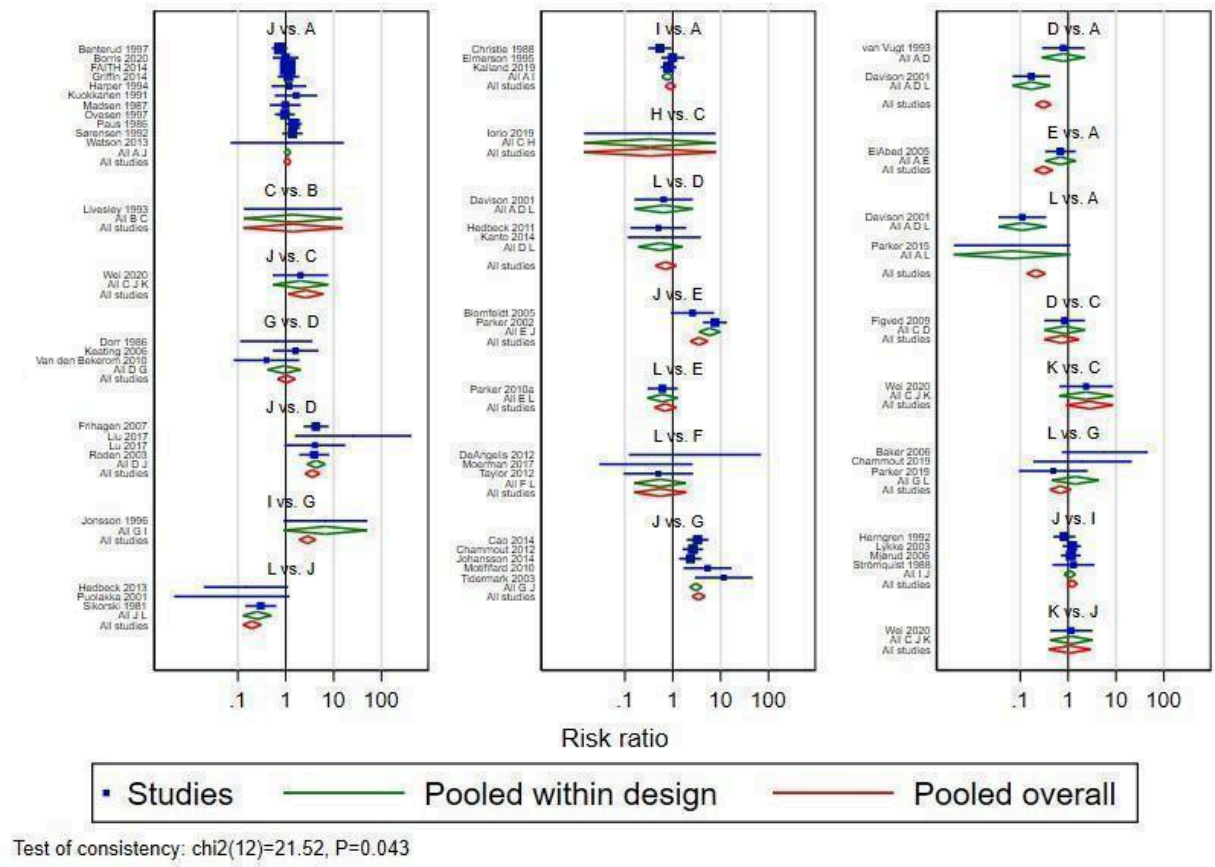
- Cemented modern unipolar HA (RR 10.66, 95% CI 3.85 to 29.50, favours cemented modern unipolar; 2 studies, 233 participants).

We noted fewer returns to theatre when a cemented modern bipolar HA was used compared to the following.

- Dynamic fixed angle plate (RR 0.32, 95% CI 0.15 to 0.65, favours cemented modern bipolar; 2 studies, 226 participants).

In the remaining comparisons, we found no evidence between any of the treatments (Table 14; Figure 24).

Figure 24. Network forest plot for unplanned return to theatre. Treatment arms - A: dynamic fixed angle plate; B: uncemented first-generation bipolar hemiarthroplasty; C: uncemented modern bipolar hemiarthroplasty;D: cemented modern bipolar hemiarthroplasty; E: uncemented first-generation unipolar hemiarthroplasty; F: uncemented modern unipolar hemiarthroplasty; G: total hip arthroplasty; H: dual-mobility total hip arthroplasty; I: pins; J: screws; K: non-operative treatment; L: cemented modern unipolar hemiarthroplasty



Network meta-analysis

The global test for inconsistency was non-significant (P = 0.043).

We noted more unplanned returns to theatre when a dynamic fixed angle plate was used, compared to the following treatments.

- Cemented modern unipolar HA (RR 4.63, 95% CI 2.94 to 7.30, favours cemented modern unipolar HA); derived from direct evidence as above, and indirect evidence (RR 3.88, 95% CI 2.37 to 6.36).
- Uncemented modern bipolar HA (RR 0.41, 95% CI 0.17 to 0.99, favours uncemented modern bipolar HA); derived only from indirect evidence.
- Cemented modern bipolar HA (RR 0.30, 95% CI 0.21 to 0.44, favours cemented modern bipolar HA); derived from direct evidence as above, and indirect evidence (RR 0.30, 95% CI 0.19 to 0.46).
- Uncemented first-generation unipolar HA (RR 0.31, 95% CI 0.20 to 0.48, favours uncemented first-generation unipolar HA); derived from direct evidence (RR 0.69, 95% CI 0.32 to 1.48; 1

study, 122 participants) and indirect evidence (RR 0.22, 95% CI 0.13 to 0.35).
- THA with single articulation (RR 0.31, 95% CI 0.22 to 0.44, favours THA); derived only from indirect evidence.

We noted more unplanned returns to theatre when screws were used, compared to the following treatments.

- Cemented modern unipolar HA (RR 5.04, 95% CI 3.25 to 7.82, favours cemented modern unipolar HA); derived from direct evidence as above, and indirect evidence (RR 5.71, 95% CI 3.31 to 9.85).
- Uncemented modern bipolar HA (RR 2.62, 95% CI 1.11 to 6.16, favours uncemented modern bipolar HA); derived from direct evidence (RR 2.04, 95% CI 0.52 to 8.07; 1 study, 103 participants) and indirect evidence (RR 3.08, 95% CI 1.03 to 9.23, favours screws).
- Cemented modern bipolar HA (RR 3.59, 95% CI 2.54 to 5.08, favours cemented modern bipolar HA): derived from direct evidence as above, and indirect evidence (RR 2.94, 95% CI 1.79 to 4.83).
- Uncemented first-generation unipolar HA (RR 3.53, 95% CI 2.31 to 5.39, favours uncemented first-generation unipolar HA); derived from direct evidence as above, and indirect evidence (RR 1.99, 95% CI 1.12 to 3.55).
- THA with single articulation (RR 3.47, 95% CI 2.53 to 4.76, favours THA); derived from direct evidence as above, and indirect evidence (RR 5.49, 95% CI 2.73 to 11.03).

We noted more unplanned returns to theatre when pins were used, compared to the following treatments.

- Cemented modern unipolar HA (RR 4.16, 95% CI 2.53 to 6.84, favours cemented modern unipolar HA); derived only from indirect evidence.
- Cemented modern bipolar HA (RR 2.96, 95% CI 1.95 to 4.50, favours cemented modern bipolar HA); derived only from indirect evidence.
- Uncemented first-generation unipolar HA (RR 2.91, 95% CI 1.80 to 4.72, favours uncemented first-generation unipolar HA); derived only from indirect evidence.
- THA with single articulation (RR 2.86, 95% CI 1.93 to 4.26, favours THA); derived from direct evidence (RR 6.71, 95% CI 0.87 to 51.77; 1 study, 50 participants) and indirect evidence (RR 2.77, 95% CI 1.86 to 4.13).

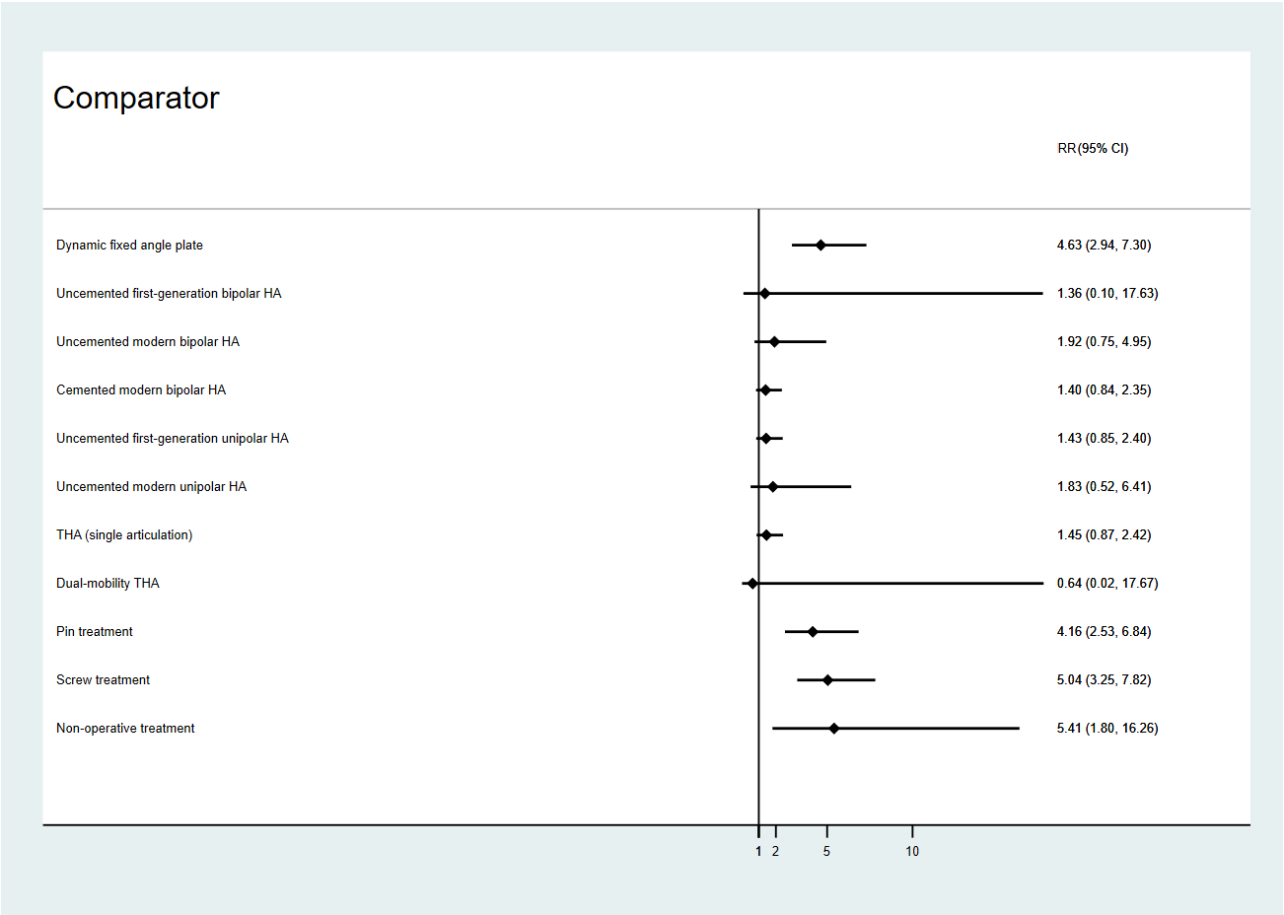
We noted more unplanned returns to theatre when non-operative treatment was used, compared to the following treatments.

- Cemented modern unipolar HA (RR 5.41, 95% CI 1.80 to 16.26, favours cemented modern unipolar HA); derived only from indirect evidence.
- Cemented modern bipolar HA (RR 3.85, 95% CI 1.35 to 10.99, favours cemented modern bipolar HA); derived only from indirect evidence.
- Uncemented first-generation unipolar HA (RR 3.79, 95% CI 1.26 to 11.36, favours uncemented first-generation unipolar HA); derived only from indirect evidence.
- THA with single articulation (RR 3.73, 95% CI 1.29 to 10.74, favours THA); derived only from indirect evidence.

In the remaining comparisons, we found no evidence of a difference between any of the treatments in unplanned return to theatre (Table 14).

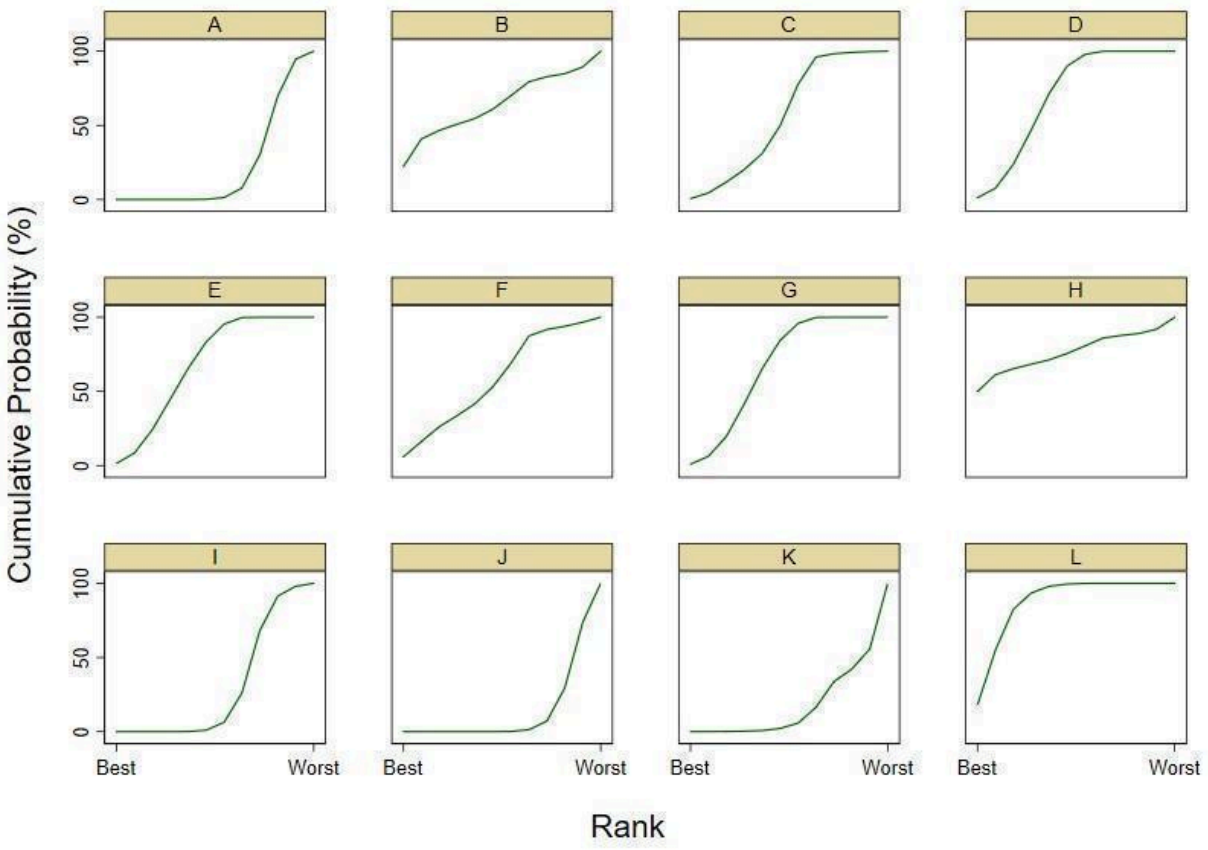
A summary of this outcome, compared to cemented modern unipolar HA, is in Summary of findings 3, and we present the network estimates against this reference comparator in Figure 25. The certainty of the evidence ranged from low to very low. We downgraded the evidence for all treatments by one level for risk of bias because all studies in the direct or indirect estimates (or both estimates) had high risk of detection bias and unclear risks of bias in at least one domain. We also downgraded a further level for risk of bias if estimates included studies at high risk of selection bias or 'other bias'. We noted that gender and age were largely consistent between studies, but it is possible that fracture displacement may affect the transitivity assumption for this network, and we downgraded some estimates when intransitivity was more apparent. There was no evidence of incoherence, but we downgraded estimates that included evidence of benefits as wells as harms for imprecision.

Figure 25. Unplanned return to theatre. Network estimates for treatments compared against cemented modern unipolar HA. CI: confidence interval;HA: hemiarthroplasty; RR: risk ratios; THA: total hip arthroplasty



We found that arthroplasty seemed to have the greatest likelihood of being ranked highly — that is, less likely to undergo unplanned return to theatre — amongst which cemented modern unipolar HA was best (mean ranks 2.5 to 6.1; SUCRA value 0.9 to 0.5). Internal fixation treatments and non-operative treatment had generally similar low probabilities of being the best treatment (Table 15; Figure 26) with almost no difference between mean ranks or SUCRA values (9.1 to 10.9 and 0.3 to 0.1, respectively). Visual inspection of the summary of the network-estimated RRs in Figure 25 yielded very similar findings, and illustrated that the size of the effect was large and clinically important for all non-arthroplasty treatments. There was a tendency for an increased risk of unplanned return to theatre for all of the arthroplasty treatments compared with the reference cemented modern unipolar HA, with little evidence to suggest the size of this difference varied strongly between the arthroplasty treatments.

Figure 26. Cumulative ranking probability curves for each treatment in the unplanned return to theatre outcome network. Each curve corresponds to the cumulative probability for all treatment ranks. From left to right along the x-axis are the possible rankings for each treatment (12 in total; only best (1st) and worst (12th) shown in Figure). Probabilities of each ranking are cumulatively summed from best to worst along the x-axis for each treatment. Treatment arms - A: dynamic fixed angle plate; B: uncemented first-generation bipolar hemiarthroplasty; C: uncemented modern bipolar hemiarthroplasty;D: cemented modern bipolar hemiarthroplasty; E: uncemented first-generation unipolar hemiarthroplasty; F: uncemented modern unipolar hemiarthroplasty; G: total hip arthroplasty; H: dual-mobility total hip arthroplasty; I: pins; J: screws; K: non-operative treatment; L: cemented modern unipolar hemiarthroplasty



DISCUSSION

Summary of main results

In the review, we included 119 studies (102 RCTs, 17 quasi-RCTs) with 17,653 participants with 17,669 fractures. All studies reported intracapsular fractures. We selected 12 interventions that presented the most clinically relevant distinctions between treatments, and which still yielded sufficient data from which to conduct network meta-analysis. Overall, we included 75 studies (with 11,855 participants) in our network meta-analyses. We selected mortality and health-related quality of life (HRQoL) at 12 months and unplanned return to theatre as the primary analyses, balancing our prespecified outcome instruments with the availability of studies and data at each time point.

We found that cemented modern unipolar hemiarthroplasty (HA), dynamic fixed angle plate and pins seemed to have the greatest likelihood of reducing mortality at 12 months. Mortality within 12 months of surgery was estimated, from the included studies, to be 23.5% amongst people treated with cemented modern unipolar HA. Based on low-certainty evidence, uncemented modern bipolar HA (RR 1.37, 95% CI 1.02 to 1.85; derived only from indirect evidence) and total hip arthroplasty (THA) (single articulation) (network estimate RR 1.62, 95% CI 1.13 to 2.32; derived from direct evidence from 2 studies with 225 participants, and indirect evidence) had higher mortality than the reference treatment. We noted no evidence of any differences in mortality at 12 months for the remaining treatments; the certainty of the evidence for these other treatments ranged from low to very low.

We found that THA (single articulation), cemented modern bipolar HA and uncemented modern bipolar HA seemed to have the greatest likelihood of improving HRQoL at 12 months. This network was comparatively sparse compared to other outcomes and the

certainty of the evidence was very low. We noted no evidence of any differences in HRQoL scores at 12 months.

We found that arthroplasty treatments seemed to have a greater likelihood of reducing unplanned return to theatre than internal fixation and non-operative treatment. We estimated from the included studies that 4.3% of participants who received a cemented modern unipolar HA returned to theatre during the study follow-up. We found low-certainty evidence that more participants returned to theatre if they were treated with a dynamic fixed angle plate (network estimate RR 4.43, 95% CI 2.94 to 7.30; from direct evidence from 1 study with 190 participants, and indirect evidence). We found very low-certainty evidence that more participants returned to theatre when treated with pins (RR 4.16, 95% CI 2.53 to 6.84; only from indirect evidence), screws (network estimate RR 5.04, 95% CI 3.25 to 7.82; from direct evidence from 2 studies with 278 participants, and indirect evidence), and non-operative treatment (RR 5.41, 95% CI 1.80 to 16.26; only from indirect evidence). Amongst only arthroplasty treatments, in particular for THA (single articulation), there was a tendency for an increased risk of unplanned return to theatre compared with cemented modern unipolar HA, with little evidence to suggest the size of this difference varied strongly between the arthroplasty treatments.

Overall completeness and applicability of evidence

Participants in this review all had intracapsular fractures. Where relevant baseline characteristics were reported, we noted that the majority of the studies included participants aged between 60 and 87 years, and that most participants were female. Therefore, we assess that the included studies are largely representative of the general hip fracture population. However, we found that few studies reported American Society of Anesthesiologists (ASA) status or presence of cognitive impairment at baseline, such that we could not confidently state that the included studies were similarly representative for these characteristics. Although most participants had displaced fractures, we noted some variation in fracture classification, particularly amongst studies of internal fixation which included more undisplaced fractures. However, there were insufficient studies reporting this variation fully to be able to explore this effectively through subgroup analysis.

We noted that studies included in the network meta-analysis were published between 1977 and 2020, and almost a third of these were published before 2000. Due to the limitations in the quality of the reporting in these older studies, we could not easily judge whether patient care protocols were equivalent to current standards of care. It is certainly possible that important developments have been made in co-interventions, such as the introduction of orthogeriatric care in some parts of the world, that have yielded improved outcomes for patients. We are unable to comment on whether such co-interventions may have changed the estimates of the relative benefits and harms between treatments reported here, or rather changed the absolute risks following treatment for this injury.

Quality of the evidence

The overall certainty of the evidence for the outcomes in this review was low to very low. This was largely owing to risks of bias in the included studies. Many studies included in this review predate widespread uptake of current standards of reporting, such as preregistration of trial protocols and adherence to the CONSORT statement. It is therefore perhaps not surprising that this is reflected in the grade of the evidence. We assessed that many studies were at unclear risk of selection bias because they did not provide information about the allocation methods, and some were at high risk of bias because they used quasi-randomised methods to allocate participants to groups. We also assessed all studies to be at a high risk of detection bias for the outcome of unplanned return to theatre.

We found that many of the network estimates were imprecise, with confidence intervals that included clinical benefits as well as possible harms, and this reduced our certainty in the estimates for most treatments. We could not rule out that variation in fracture displacement may have affected the transitivity assumption in the networks, and for some treatments (particularly those comparing internal fixation implants), we downgraded the certainty of the evidence for the network estimate for intransitivity. A small number of direct and indirect estimates included inconsistency, and we downgraded the certainty of the evidence for this, where appropriate.

In most cases, there was no evidence of incoherence. In our early assessments of the networks, it was noted that one particular study appeared to contribute to a lack of consistency. Although we could not determine the exact reason for this, we suspected that it was driven by particularly high risks of bias in the study, and we judged that it was most appropriate to remove this study from all the networks. We did not downgrade the evidence for indirectness (the studies included the relevant population, treatments and outcome measures), and we did not downgrade for publication bias. We did not formally assess small study bias, though we did produce comparison-adjusted funnel plots. There were few studies in each node, though overall, there was no indication of an issue in this regard.

Potential biases in the review process

The review authors conducted a thorough search and independently assessed study eligibility, extracted data, and assessed risk of bias in the included studies before reaching consensus together or with one other review author.

Our decisions on lumping/splitting of nodes were necessarily subjective and meant that some studies were inevitably excluded from the networks. This often occurred because of a lack of detail in reporting interventions fully. Sometimes the choice of a pragmatic study design, where interventions were allowed that were described within separated nodes, precluded including a study within a network. We also were unable to include studies that compared two treatments within a node (such as two different types of screws).

We recognise that important co-interventions are likely to have been introduced into clinical practice, which are not represented in the network. We did not undertake any analyses to explore how limiting the studies may have impacted on our findings.

In the conduct of this large review, we have either chosen to alter or have been unable to deliver all of our planned methods. Given the complexity of the review, the sparsity of many of the networks, and the often unclear and high risk of bias of included studies, we chose not to perform any sensitivity analyses. We chose to include only older participants, such that some potentially eligible studies were excluded, but this ensured less variation in

age and that the evidence was representative of the target fragility fracture population. During data extraction, it became apparent that multiple time points were reported inconsistently between studies. We chose to create additional networks rather than group widely across time windows. Balancing this against the availability of data, we elected to move away from our prespecified preference for early time points to prioritise the more-often-reported 12 month time point.

Agreements and disagreements with other studies or reviews

Few network meta-analyses of treatments for fragility intracapsular hip fracture have been reported. Zhang 2017 reported mortality, dislocation, infection and re-operation in a similar population for a subset of treatments. Only 40 studies were included, reporting data from 6141 participants. There was little evidence of a difference in mortality, but similar findings that arthroplasty — particularly cemented unipolar HA — yields reduced re-operation risks compared with internal fixation. The review by Zhang and colleagues did not report HRQoL outcomes.

In the preparation of this network meta-analysis, the author team has been involved in the production and updating of a suite of reviews that are relevant in the interpretation of the findings reported here (Lewis 2021; Lewis 2022c). These recently published reviews conclude that there is little evidence from direct estimates of any important differences between internal fixation implants, and that cemented modern HA is likely to yield the best global outcome after arthroplasty, although there may be a role for THA for a subset of people.

An older review from 2006, comparing internal fixation with arthroplasty, was unable to reach clear conclusions regarding the majority of outcomes, except for an increased risk of re-operation with internal fixation (Parker 2006b). This finding mirrors our network meta-analysis but, importantly, we have been able to provide more precise estimates of differences in mortality and, for the first time, differences in HRQoL outcomes.

Direct estimates are increasingly becoming available for differences between major treatment categories from recently published large-scale pragmatic studies, such as FAITH 2017, Fernandez 2022 and HEALTH 2019. The findings from these studies echo those from this network meta-analysis, supporting our findings of only small differences between internal fixation implants and between HA and THA, but a benefit associated with cemented arthroplasty designs.

AUTHORS' CONCLUSIONS

Implications for practice

Across the networks, we found that there was considerable variability in the ranking of each treatment, such that there was no one outstanding, or subset of outstanding, superior treatments. However, cemented modern arthroplasties — both unipolar and bipolar — tended to more often yield better outcomes than alternative treatments and may be a more successful approach than attempting internal fixation. We recognise that the majority of our data are derived from participants with displaced intracapsular fractures. There is no evidence of a difference between total hip arthroplasty (THA) (single articulation) and cemented modern unipolar hemiarthroplasty (HA) in risk of unplanned return to theatre, mortality or health-related quality of life (HRQoL). This may be an appropriate treatment for a subset of people with intracapsular fracture, but we have not explored this in the present review.

Implications for research

Hip fracture continues to be a dynamic area within clinical research in trauma and orthopaedic surgery. We have identified 17 ongoing studies with an estimated enrolment of more than 10,000 participants. Two very large studies of note are Wolf 2020a, comparing dual-mobility versus standard THA, and Wolf 2020b, comparing screws versus THA, recruiting samples of 1600 and 1440 participants, respectively.

However, despite this ongoing research interest, we note that many studies, even those reported more recently, are assessed to be at unclear or high risk of bias and we urge authors to report studies in accordance with the CONSORT statement. We also encourage authors to review the core outcome set for hip fracture (Haywood 2014), and to ensure that data are reported, at a minimum, at four months - the time point prioritised by people with hip fracture.

It is unlikely that additional studies will yield fundamental changes in our knowledge of the clinical outcomes of major classes of treatments following the treatment of people with displaced intracapsular fragility fractures. However, future research should focus on health economic evaluations and testing of emerging technologies, particularly amongst the more effective arthroplasty interventions — for example, dual-mobility THA — to properly assess their efficacy prior to widespread adoption. This review has highlighted the relative paucity of data available regarding undisplaced fractures. We encourage authors to report effects within both these subgroups in future. We await the results of ISRCTN28566489 comparing internal fixation with arthroplasty for undisplaced fractures.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

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

Abdelkhalek 2011

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** HA: bipolar vs unipolar
Participants	**Total number of randomised participants:** 50 **Inclusion criteria:** elderly people with displaced femoral neck fractures **Exclusion criteria:** not reported **Setting:** single centre; hospital; Egypt **Baseline characteristics (overall)** • Age, mean (range): 63.5 (55 to 72) years • Gender, M/F: 16/34 **Note:** • study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, BMI, mobility assessment, place of residence, cognitive status, preoperative waiting time
Interventions	**General details:** posterior surgical approach; the decision to use cement was applied on an individual basis; prophylactic low-molecular-weight heparin 12 hours preoperatively, and daily postoperatively for 5 days; ambulation with weight bearing as tolerated was started on POD2 or POD3. All participants were followed up and clinically evaluated at 6 weeks, 3 months, 6 months, 12 months and then annually. **Intervention group 1** • HA bipolar; 12 cemented, 13 uncemented; further details not reported • Randomised = 25 **Intervention group 2** • HA unipolar; 15 cemented Thompson; 10 Austin-Moore; further details not reported • Randomised = 25
Outcomes	**Outcomes measured/reported by study authors:** HHS (> 90 excellent, 80 to 90 good, 70 to 80 fair, < 70 poor); migration; acetabular erosion; subsidence; femoral loosening; pain (none, slight, mild, severe); dislocation; infection; DVT; range of motion; limping **Outcomes relevant to the review:** unplanned return to theatre

Abdelkhalek 2011 *(Continued)*

Notes:

- time points not reported. Final follow-up ranged from 2 to 6 years, "average of 4.4 years"
- unplanned return to theatre: reasons for re-operation prosthetic replacement; types of re-operation were replacement with arthroplasty

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** 2002 to 2007 **Note:** - we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Alberts 1989

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus smooth pin
Participants	**Total number of randomised participants:** 137 **Inclusion criteria:** recent femoral neck fracture **Exclusion criteria:** not reported **Setting:** single centre; hospital; Sweden **Baseline characteristics (overall)** - Age, mean (range): 77 (39 to 99) years - Gender, M/F: 41/96 - Fracture classification, undisplaced/displaced - Garden's I, n: 28; Garden's II, n: 20; Garden's III, n: 38; Garden's IV, n: 51 **Note:** - study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, BMI, medication, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, preoperative waiting time
Interventions	**General details:** one of 17 surgeons (at least 2 years experience of fracture surgery with either technique); no prophylactic antibiotics or anticoagulants; closed reduction on extension table prior to skin incision; all participants who were ambulatory prior to fracture were mobilised on POD1 with the aid of frames or crutches - full weight bearing allowed; clinical examinations were at 1 week and 2 months postoperatively **Intervention group 1** - 3 Scand screws - Randomised = unknown; losses = 11 at 1 year, and 20 at 2 years (all owing to death); analysed = 63 **Intervention group 2** - 3 Nyström nails, 1 at lesser trochanter and 2 proximal - Randomised = unknown; losses = 16 at 1 year, and 26 at 2 years (all owing to death); analysed = 70

Alberts 1989 *(Continued)*

	Note: • 4 participants were excluded after randomisation because of failure to reduce fracture. It is not reported to which group these participants were initially allocated.
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 12 months and 24 months); complications (moderate sliding, pronounced sliding, fracture of fixation material, penetration, redisplacement, non-union, late segmental collapse, superficial infection, deep infection - at 12 months and 24 months); overall clinical grading (scoring system that includes pain, tenderness and mobility) **Outcomes relevant to the review:** mortality (at 12 months)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomised but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Low risk	The surgeons in the study were experienced in both techniques
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was balanced between groups and was owing to death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Alho 1998

Study characteristics

Methods	RCT; parallel design **Review comparison group:** Ulleval screws (3 screws); Olmed screws (2 screws); Tronzo screws (2 screws)

Alho 1998 *(Continued)*

Note:

- this study had three comparisons conducted at three separate hospitals, comparing a new screw system (Ulleval) with the currently-used screw system (Olmed or Tronzo). Study authors reported data separately according to the hospital

Participants	**Total number of randomised participants:** 662 (varying numbers reported in abstracts) **Inclusion criteria:** ≥ 54 years of age; displaced fracture; previously unaffected, fracture treated within 3 days **Exclusion criteria:** undisplaced; fracture could not be reduced **Setting:** multi-centre; 3 hospitals; Norway **Baseline characteristics** Rogaland Central Hospital (overall data: only reported for analysed participants) • Age, median (range): 79 (54 to 97) years • Gender, M/F: 149/42 Akershus Central Hospital (overall data: only reported for analysed participants) • Age, median (range): 78 (54 to 96) • Gender, M/F: 203/46 Ullevaal Hospital (overall data: only reported for analysed participants) • Age, median (range): 81 (56 to 97) • Gender, M/F: 130/37 Overall characteristics for all hospitals • Mobility assessment: 70% walked without aid • Place of residence: 71% lived at home **Note:** • study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, BMI, medication, comorbidities, mobility assessment, cognitive status, ASA status, preoperative waiting time • study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups
Interventions	**General details:** number of surgeons not reported; weight bearing encouraged; thrombosis prophylaxis provided; no prophylactic antibiotics Rogaland Central Hospital • Olmed screws (Olmed, Sweden); 2 screws. Number randomised to group is not reported; analysed = 89 • Ulleval hip screws (Howmedica, Sweden); 3 screws. Number randomised to group is not reported Akershus Central Hospital • Tronzo Screws (Biomet, England); 2 screws. Number randomised to group is not reported; analysed = 130 • Ulleval hip screws (Howmedica, Sweden); 3 screws. Number randomised to group is not reported Ullevaal Hospital • Olmed screws (Olmed, Sweden); 2 screws. Number randomised to group is not reported; analysed for unplanned return to theatre = 86

Alho 1998 *(Continued)*

- Ulleval hip screws (Howmedica, Sweden); 3 screws. Number randomised to group is not reported

Note:

- losses by group were not reported. Overall, there were 55 losses (11 = < 54 years of age; 29 = undisplaced fractures; 9 = fracture could not be reduced; 6 = lost to follow-up)

Outcomes	**Outcomes measured/reported by study authors:** re-operation; failure of fixation; habitat; walking without aids (these data were not reported by type of implant); healing of fracture: united, non-union or salvage re-operation; recorded at 3, 12 and 24 months **Outcomes relevant to the review:** unplanned return to theatre (24 months) **Notes:** • reasons for re-operation not reported; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** 1991 to 1993 **Note:** • we extracted from primary reference unless otherwise stated; multiple other reports published as conference abstracts by the study authors, some include other sites at Huddinge, Helsinki and Toolo but expected to include same participants from the hospitals included here • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Baker 2006

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA versus HA

Participants	**Total number of randomised participants:** 81
	
	Inclusion criteria: diagnosis of a displaced fracture; > 60 years of age, a normal Abbreviated Mini Mental Test score, ability to walk ≥ 0.5 miles (≥ 0.8 km), ability to live independently (without reliance on a caregiver), a non-pathological fracture, a hip with no or minimal osteoarthritic changes
	
	Exclusion criteria: age of < 60 years, medical or physical comorbidities that limited the walking distance to < 0.5 miles (0.8 km), a pre-existing hip abnormality requiring total hip arthroplasty, a pathological fracture secondary to malignant disease
	
	Setting: 3 centres; hospital; UK
	
	Intervention group 1 (THA)
	
	• Age, mean (range): 74.2 (63 to 86) years
	• Gender, M/F: 8/32
	• Mobility assessment, walking distance, mean (range): 3.5 (0.8 to 8.0) km
	• Cognitive status, Abbreviated Mini Mental score (points), mean (range): 9.83 (7 to 10)
	• ASA status: median (range) II (range I to III)
	• Additional information:
	  ◦ OHS mean (range): 12.90 (12 to 14)
	  ◦ SF-36 PCS, mean (range): 48.01 (25.2 to 56.6), MCS, mean (range): 55.52 (33.8 to 64.2)

Baker 2006 *(Continued)*

- Preoperative waiting time, mean: 1.75 days

Intervention group 2 (HA)

- Age, mean (range): 75.83 (66 to 86) years
- Gender, M/F: 9/32
- Mobility assessment, walking distance, mean (range): 3.5 (0.8 to 9.7) km
- Cognitive status, AMTS (points), mean (range): 9.98 (9 to 10)
- ASA status: median (range) II (I to III)
- Additional information:
  - OHS mean (range): 12.12 (12 to 14)
  - SFS-36 PCS, mean (range): 44.35 (19.7 to 66.8), MCS, mean (range): 54.76 (35.9 to 66.9)
- Preoperative waiting time, mean: 1.95 days

Note:

- study authors did not report any baseline data for: smoking history, BMI, medication, comorbidities, place of residence

Interventions	**General details:** surgeons of similar levels of training; HA: 31 by residents, 7 by consultants, 2 by senior house officers, 1 not documented; THA: 31 by residents, 9 by consultants; all received the same cemented femoral component (collarless polished tapered stem (Zimmer, Warsaw, Indiana)); transgluteal lateral approach. Followed up at 3 months, 1 year and 3 years after surgery **Intervention group 1** • THA; 28 mm femoral head articulating with an all-polyethylene Zimmer cemented acetabular cup without a long posterior wall (Zimmer) • Randomised = 40; losses = 4 (3 died, 1 unable to attend the follow-up); analysed at final follow-up = 36 **Intervention group 2** • HA; Endo Femoral Head (Zimmer); cemented; unipolar • Randomised = 41; losses = 8 (7 died, 1 unable to attend the follow-up); analysed at final follow-up = 33
Outcomes	**Outcomes measured/reported by study authors:** mortality (at 3 years and 9 years); OHS (3 years and 9 years); HRQoL (SF-36, PCS and MCS; at 3 years and 9 years); walking distance (patients reported); postoperative complications within 30 days after surgery using anteroposterior and lateral radiographs: acetabular, erosion, polyethylene wear, femoral stem subsidence, and component migration, dislocation, infection, thromboembolic events, pneumonia, atrial fibrillation, haematemesis, pressure sore, hyponatraemia **Outcomes relevant to the review:** mortality (at 9 years); unplanned return to theatre; HRQoL **Notes:** • follow-up was an average of 39 months. However, we also used data at 9 years, as reported in a linked publication (Avery 2011) • we used data for HRQoL (SF-36; PCS) as reported in Parker 2010a, in which SDs were calculated from P values
Notes	**Funding/sponsor/declarations of interest:** no grants or external funding **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement

Baker 2006 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Described as randomised but no additional details
Allocation concealment (selection bias)	Unclear risk	"Randomization was performed with use of sealed envelopes that were opened before surgery"; insufficient information because study authors do not report if envelopes were sealed or opaque
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that the interventions were all performed by surgeons of similar training but we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Study authors did not report whether participants were blinded to treatment allocation. However, we did not expect that lack of blinding would influence participants' assessment of their quality of life
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Benterud 1997

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Total number of randomised participants:** 225 **Inclusion criteria:** femoral neck fractures; displaced subcapital fracture; > 70 years of age **Exclusion criteria:** not specified. However, study authors report that 15 participants were excluded because they had undisplaced fractures, and 1 participant was excluded because the alternative type of implant was used **Setting:** single centre; hospital; Norway

Benterud 1997 *(Continued)*

	Baseline characteristics (overall) • Age, median (range): male: 80 (63 to 95) years; female: 81 (63 to 97) years • Gender, M/F: 47/178 **Note:** • study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, BMI, medication, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, preoperative waiting time
Interventions	**General details:** unknown number of clinicians; reduction performed with traction table using image intensifier; within 3 days of injury **Intervention group 1** • Two parallel hip screws (Olmed) • Randomised = 117; 48 attended final follow-up at 39 months (range 22 to 51 months), however, outcome data were reported in tables accounting for all randomised participants **Intervention group 2** • Richards sliding screw plate supplemented by a parallel AO 6.5 mm cancellous screw • Randomised = 108; 44 attended final follow-up at 39 months (range 22 to 51 months), however, outcome data were reported in tables accounting for all randomised participants **Note:** • study authors reported 203 participants were followed up at 3 months, and that 82 participants were alive after 3 years
Outcomes	**Outcomes measured/reported by study authors:** re-operation due to failure (available at 3 months and 3 years), infection (reported as a local complication, and we assumed this was wound infection), non-union, segmental collapse; living at home (at 3 months) **Outcomes relevant to the review:** unplanned return to theatre (at 3 years) **Note:** • unplanned return to theatre: reasons for re-operation deep infection; types of re-operation were replacement with arthroplasty, removal of fixation or refixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomised but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance

Benterud 1997 *(Continued)*

Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were experienced in both techniques
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors reported overall deaths (rather than by group), which were expected in this population; data were reported in tables for all randomised participants
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Blomfeldt 2005

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** internal fixation (cannulated screws) vs HA (uncemented Austin-Moore)

Participants	**Total number of randomised participants:** 60
	
	Inclusion criteria: displaced fracture of femoral neck (Garden's III or IV); ≥ 70 years of age; diagnosed with dementia and/or severe cognitive dysfunction, independent walking capability with or without walking aid
	
	Exclusion criteria: fractures not suitable for internal fixation such as pathological fractures or displaced fractures of > 24 hours; rheumatoid arthritis or osteoarthritis
	
	Setting: single centre; hospital; Sweden
	
	Baseline characteristics
	
	Intervention group 1 (internal fixation)
	
	• Age, mean (SD): 83.6 (± 6.3) years
	• Gender, M/F: 4/26
	• Comorbidities, using Ceder C, n: 30
	• Mobility assessment, no walking aid or just one stick, n: 18
	• Place of residence, living independently, n: 14
	• Cognitive status, using SPMSQ, mean (SD): 0.9 (± 1.4)
	• Additional information:
	  ○ HRQoL, using EQ-5D, mean (SD): 0.27 (± 0.2)
	  ○ ADL, using Katz A to B, n: 4
	
	Intervention group 2 (HA)
	
	• Age, mean (SD): 84 (± 5.9) years
	• Gender, M/F: 2/28
	• Comorbidities, using Ceder C, n: 30

Blomfeldt 2005 *(Continued)*

- Mobility assessment, no walking aid or just one stick, n: 19
- Place of residence, living independently, n: 15
- Cognitive status, using SPMSQ, mean (SD): 0.7 (± 1.4)
- Additional information:
  - HRQoL, using EQ-5D, mean (SD): 0.26 (± 0.13)
  - ADL, using Katz A to B, n: 3

Note:

- study authors report no baseline data for: smoking history, medication, BMI, ASA status, preoperative waiting time

Interventions	**General details:** carried out by 1 of 2 surgeons experienced in both techniques; both mobilised to weight bearing as tolerated **Intervention group 1:** • internal fixation with 2 cannulated screws (DePuy/Johnson & Johnson, Sollentuna, Sweden); participants were given low-molecular-weight heparin preoperatively and for 10 days postoperatively. • number randomised = 30, losses = 14 (12 died within 24 months; 1 lost to follow-up at 12 months); analysed for all outcomes at 4 months = 30; analysed for all outcomes at 24 months = 30 **Intervention group 2:** • uncemented Austin Moore HA (DePuy/Johnson & Johnson); carried out using anterolateral modified-Hardinge approach; participants were given low-molecular-weight heparin preoperatively and for 10 days postoperatively. Also given cefuroxime 1.5 g preoperatively, followed by 2 additional doses during the first 24 hours • number randomised = 30, losses = 12 (died within 24 months); analysed for all outcomes at 4 months and 24 months = 30 **Note:** • study authors do not report type of anaesthesia
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at: perioperatively, 4 months, 12 months, 24 months); reoperation (available at: 4 months, 12 months, 24 months); HRQoL (available at 4 months, 12 months, 24 months); intraoperative blood loss, blood transfusion; mean operating time; reduction; complications; ADL, periprosthetic fractures, nonunion, hip function (Charnley Hip Score), independent living at end of follow-up **Outcomes relevant to the review:** mortality (at 4 months and 12 months); unplanned return to theatre (reoperation; at 4 months and 24 months); HRQoL (EQ-5D; at 4 months, 12 months)
Notes	**Funding/sponsorship/declarations of interest:** in part by grants from Trygg-Hansa Insurance Company, Swedish Society for Medical Research, Swedish Orthopaedic Association, and Stockholm County Council. No commercial funding **Study dates:** not reported **From Erratum:** "It is regretted that two patients from the internal fixation group treated with primary hemiarthroplasty when their fractures proved to be irreducible were reported as excluded. Their outcomes were reported according to the intention-to-treat principle except for the data on operating time, blood loss, fracture reduction and screw position."

Risk of bias

Bias	Authors' judgement	Support for judgement

Blomfeldt 2005 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Described as randomised but no additional details
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes; no information about whether envelopes are sequentially-numbered or opaque
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to interventions. We did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Low risk	Surgeons were experienced in both techniques
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not believe that lack of blinding would influence data for this outcome
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Only one participant lost to follow-up which is clearly reported. Other losses are owing to death which is expected in this population
Other bias	Unclear risk	We noted that participants in the HA group were given prophylactic antibiotics during the perioperative period. These antibiotics were not given to participants in the internal fixation group. We were uncertain whether this difference in treatment could influence outcomes
Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trial registration or prepublished protocol; it is not feasible to effectively assess risk of reporting bias without these documents

Blomfeldt 2007

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA versus HA
Participants	**Total number of randomised participants:** 120 **Inclusion criteria:** 70 to 90 years of age; absence of severe cognitive dysfunction demonstrated by ≥ 3 correct answers on the 10-item SPMSQ; non-institutionalised independent living status; pre-injury independent walking capability with or without aids. **Exclusion criteria:** pathological fractures; displaced fractures present for > 48 hours before presentation; rheumatoid arthritis; osteoarthritis **Setting:** single centre; hospital; Sweden **Intervention group 1** (THA)

Blomfeldt 2007 *(Continued)*

- Age, mean (SD, range): 80.5 (± 5.1, 70.2 to 89.7) years
- Gender, M/F: 13/47
- Comorbidities, Ceder A or B, n: 53
- Mobility assessment, no walking aid or just one stick, n: 56
- Cognitive status, using SPMSQ, mean (SD, range): 9.1 (± 0.21, 7 to 10)
- Additional information:
  - ADL, A or B, n: 58
  - EQ-5D, mean (SD, range): 0.80 (± 0.21, 0.12 to 1.0)

Intervention group 2 (HA)

- Age, mean (SD, range): 80.7(± 5.1, 70 to 89) years
- Gender, M/F: 6/54
- Comorbidities, Ceder A or B, n: 50
- Mobility assessment, no walking aid or just one stick, n: 55
- Cognitive status, using SPMSQ, mean (SD, range): 9.0 (± 0.8, 6 to 10)
- Additional information:
  - ADL, A or B, n: 59
  - EQ-5D, mean (SD, range): 0.80 (± 0.17, 0.19 to 1.0)

Notes:

- study authors did not report any baseline data for: smoking history, medication, BMI, place of residence, preoperative waiting time

Interventions	**General details:** 1 of 9 consultants experienced in both procedures; same cementing technique was used in both groups; low-molecular-weight heparin preoperatively and for ≥ 10 days postoperatively; cefuroxime 1.5 g was given preoperatively followed by 2 additional doses during the first 24 hours; mobilised bearing full weight with the aid of 2 crutches as tolerated **Intervention group 1** • THA; modular Exeter femoral component (Howmedica, Malmö, Sweden); 28 mm head; OGEE (DePuy/Johnson & Johnson, Sollentuna, Sweden) cemented acetabular component • Randomised = 60; losses = 18 (17 died, 1 lost to follow-up); analysed for mortality = 60 **Intervention group 2** • HA bipolar; modular Exeter femoral component (Howmedica, Malmö, Sweden); 28 mm head (Bicentric, Howmedica or Universal Head Replacement) • Randomised = 60; losses = 19 (14 died, 5 lost to follow up); analysed = 60
Outcomes	**Outcomes measured/reported by study authors:** ADL (Katz; available at 4 and 12 months); HRQoL (EQ-5D); living conditions (independent or institutional); intra-operative blood loss, need for blood transfusion and duration of surgery; HHS and pain (available at 4, 12, 24, and 48 months); complications (dislocation, periprosthetic fracture, radiological signs of loosening of the femoral component, radiological signs of erosion in the acetabulum with a hemiarthroplasty, or loosening of the acetabular component in a THA, deep wound infection, superficial wound infection, pressure sores, cardiac, pulmonary, thromboembolic or cerebrovascular complications, any new fracture of the lower limb); mortality (at 12 months, 24 months, 48 months) **Outcomes relevant to the review:** mortality (at 12 months and 48 months) **Notes:** • we did not include data for HRQoL because study authors reported these data in a figure from which we could not confidently extract numerical data • we used data from an associated publication by Hedbeck and colleagues for mortality at 48 months

Blomfeldt 2007 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** supported in part by a grant from the Trygg-Hansa Insurance Company and the Stockholm County Council **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "patients were randomised by a sealed-envelope technique" Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes; no additional details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to interventions. We did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Low risk	Surgeons experienced in both techniques
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most participant loss was because of death, which is expected in this population. Few lost to follow-up, and these losses were relatively balanced between groups
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Borris 2020

Study characteristics

Methods	RCT; parallel group **Review comparison group:** screw versus fixed angle plate
Participants	**Total number of randomised participants:** 40 **Inclusion criteria:** subcapital femoral neck fracture (stable or unstable); 50 to 69 years of age with any Garden type fracture; > 70 years of age with Garden's type I or II, or with Garden's III or IV and contraindication to hip arthroplasty; operative treatment within 4 days of presenting to hospital; ambulatory prior to fracture (including with use of a cane or walker); anticipated medical optimisation of participant for operative fixation of fracture; informed consent; low-energy fracture; no other major trauma

Borris 2020 *(Continued)*

Exclusion criteria: retained implant around affected hip; abnormal opposite hip; infection around hip; disorders of bone metabolism other than osteoporosis; moderate or severe cognitive impairment; Parkinson's disease (or dementia or other neurological deficit) severe enough to compromise rehabilitation; possible problems with maintaining follow-up

Setting: single centre; hospital; Denmark

Baseline characteristics

Intervention group 1 (screws)

- Age, mean (SD): 70.6 (± 9.4) years
- Gender, M/F: 6/12
- BMI, mean (SD): 22.6 (± 3.1) kg/m^2
- Smoking history, n: yes: 5; no: 6; previous: 6; no information: 1
- Fracture classification, I/II/III/IV, n: 6/5/4/3
- Preoperative waiting time, mean (SD): 16.9 (± 10.4) hours

Intervention group 2 (Dynaloc)

- Age, mean (SD): 73 (± 13.5) years
- Gender, M/F: 10/12
- BMI, mean (SD): 23.7 (± 3.9) kg/m^2
- Smoking history, n: yes: 5; no: 17; previous: 0; no information: 0
- Fracture classification, I/II/III/IV, n: 9/11/1/1
- Preoperative waiting time, mean (SD): 15.2 (± 8.9) hours

Note:

- study authors did not report baseline characteristics for: medication, comorbidities, mobility assessment, place of residence, cognitive status, ASA status

Interventions

General details: 2 surgeons operated on a preliminary cohort of 10 patients in order to gain experience, and these surgeons were supervisors of 13 surgeons during the study (most surgeons operated in both groups); participants placed on fracture table and fractures were reduced with traction and internal rotation of leg; screw insertion using percutaneous technique in both groups; all participants given preoperative antibiotics and postoperative antithrombotic prophylaxis; immediate weight bearing allowed in both groups; follow-up after 3 months, 1 year and 2 years

Intervention group 1

- Cannulated screws
- Randomised = 18; losses = 3 (not explained); analysed for mortality and unplanned return to theatre = 18; analysed for EQ-5D = 16

Intervention group 2

- Dynaloc (Swemac AB, LIndköping, Sweden) - 3 cancellous screws locked in a small plate, which is not attached to the femoral shaft
- Randomised = 22; losses = 5 (not explained); analysed for mortality and unplanned return to theatre = 22; analysed for EQ-5D = 18

Note:

- study authors did not report type of anaesthesia used during the procedure

Outcomes

Outcomes measured/reported by study authors: leg length discrepancy, postoperative fracture collapse, SF-12, WOMAC, EQ-5D, HHS, re-operation, mortality, femoral head necrosis, infection. Data available at 12 months and 24 months

Outcomes relevant to the review: unplanned return to theatre, mortality; HRQoL

Borris 2020 *(Continued)*

Notes:

- we contacted study authors who provided data for EQ-5D scores
- unplanned return to theatre: reasons for re-operation deep infection; types of re-operation were replacement with arthroplasty or removal of fixation

Notes

Funding/sponsor/declarations of interest: online randomisation was funded by Swemac AB, Linköping, Sweden. Study authors declared no conflicts of interest

Study dates: study initiated in March 2014

Notes:

- study was terminated early because of a high rate of hardware-associated discomfort (initial plan to recruit 75 participants)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Use of centralised 24-hour computerised randomisation system
Allocation concealment (selection bias)	Low risk	Use of a centralised system
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Low risk	Both surgeons had some experience in the new device and supervised all operations
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Study authors did not report whether participants were blinded to treatment allocation. However, we did not expect that lack of blinding would influence participants' assessment of their quality of life
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Loss of some participants for HRQoL, but most of these losses were likely owing to death, and the number of losses were few
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	High risk	Study prospectively registered with a clinical trials register (NCT02030431; first received January 2014). Study authors report only two outcomes in the clinical trial report (re-operation and leg length discrepancy), but report data for other outcomes. Risk of reporting bias is low for unplanned return to theatre and high for other review outcomes

Brandfoot 2000

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 91 **Inclusion criteria:** all patients to be treated with HA **Exclusion criteria:** pathological fractures; selected for internal fixation or THA **Setting:** single centre; hospital; UK **Baseline characteristics (overall)** • Age, mean (range): 83 (63 to 97) years • Gender, M/F: 10/81 • ASA status, I/II/III/IV: 1/30/37/23 • Preoperative waiting time: 3 days (range from same day to 31 days after fracture); 75% had surgery within 3 days of fracture • Fracture classification, undisplaced/displaced: 2/89 (Gardens 1/2/3/4: 1/1/22/67) **Intervention group 1** (cemented) • Age, mean (range): 83 (70 to 94) years • Gender, M/F: 4/34 • ASA status, mean: 2.9 • Preoperative waiting time, mean: 2 days **Intervention group 2** (uncemented) • Age, mean (range): 85 (69 to 97) years • Gender, M/F: 6/47 • ASA status, mean: 2.9 • Preoperative waiting time, mean: 3 days **Note:** • study authors did not report baseline characteristics for: smoking history, BMI, mobility assessment, place of residence, cognitive status, preoperative waiting time • study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups
Interventions	**General details:** Thompson HA for both groups; performed by a consultant 9 times, specialist registrar 70, senior house officer 12; all received the same postoperative care. Routine follow-up at approximately 6 weeks and 6 to 9 months (and later, if problems identified) **Intervention group 1** • HA cemented Thompson, using Palacos with gentamycin • Randomised = 38; 7 died; analysed = 38 **Intervention group 2** • HA uncemented Thompson • Randomised = 53; 14 died; analysed = 53

Brandfoot 2000 *(Continued)*

Outcomes	**Outcomes measured/reported by study authors:** mortality; radiographs (dislocation and failures) and telephone interview; modified HHS; mean follow-up 16 months (range 8 to 20) for functional assessment **Outcomes relevant to the review:** mortality at 16 months
Notes	**Declarations/sponsorship/declarations of interest:** not reported **Study dates:** 1 January 1998 to 31 December 1998

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomised but no additional details
Allocation concealment (selection bias)	Unclear risk	Sealed envelopes used, but no further details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Low risk	Both surgeons had some experience in the new device and supervised all operations
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Cadossi 2013

Study characteristics

Methods	RCT; parallel design **Review comparison group:** THA versus HA
Participants	**Total number of randomised participants:** 96 **Inclusion criteria:** displaced intracapsular femoral neck fracture, Garden type III or IV; ≥ 70 years of age; pre-injury independent walking capability without aids

Cadossi 2013 *(Continued)*

Exclusion criteria: advanced radiological osteoarthritis or rheumatoid arthritis in the fractured hip; suspected pathological fracture; senile dementia

Setting: single centre; hospital; Italy

Baseline characteristics

Intervention group 1 (THA; data reported only for 42 participants)

- Age, mean (range): 82.3 (71 to 96) years
- Gender, M/F: 8/34
- ASA status, I/II/III/IV, n: 2/15/16/9
- Comorbidities, type, n:
  - cardiovascular: 22
  - malignancies: 8
  - pulmonary: 1
  - neurological: 4
  - diabetes: 2

Intervention group 2 (HA; data reported only for 41 participants)

- Age, mean (range): 84.2 (73 to 98) years
- Gender, M/F, n: 13/28
- ASA status, I/II/III/IV, n: 1/10/22/8
- Comorbidities, type, n:
  - cardiovascular 22
  - malignancies 2
  - pulmonary 3
  - neurological 6
  - diabetes 3

Interventions	**General details:** performed by 2 experienced surgeons; mobilised bearing full weight with the aid of 2 crutches as tolerated **Intervention group 1** • THA uncemented Conus stem and a large-diameter femoral head (Biomet, Warsaw, Indiana) • Randomised = 47 **Intervention group 2** • HA with or without cementation according to surgeon's preference; bipolar femoral head (Centrax; Howmedica Stryker; or Endoprotesi Biarticolare; Citieffe, Bologna, Italy). Simplex low-viscosity bone cement (Howmedica Stryker) • Randomised = 49
Outcomes	**Outcomes measured/reported by study authors:** mortality (data available at 1 year, 2 years, 3 years); HHS (data available at: 3 months,1 year, 2 years, 3 years); dislocation; revision operations and implant-related complications: stem subsidence, osteoarthritis of the acetabulum, protrusio acetabuli, fractures and fissures, and heterotopic ossification according to the classification of Brooker **Outcomes relevant to the review:** mortality (at 12 months and 3 years) **Note:** • outcome data for unplanned return to theatre was reported clearly in the THA group, but we could not be certain whether it was reported for all participants in the HA group
Notes	**Funding/sponsor/declarations of interest:** no external funding

Cadossi 2013 *(Continued)*

Study dates: March 2008 to April 2010

Note:

- we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Calder 1995

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: bipolar vs unipolar vs IF Note: • study also reported data for participants who were > 80 years of age. This study report is interim data for a complete study (Davison 2001). Outcomes, inclusion criteria (participant age), and baseline data for included participants are distinct, and we have presented these as separate studies
Participants	**Total number of analysed participants**: 110 (total randomised participants is not reported) **Inclusion criteria:** 65 to 79 years of age; displaced intracapsular fracture (Garden stage III to IV) **Exclusion criteria:** mental test score < 5; uncontrolled Parkinson's disease; disseminated malignancy or pathological fracture; rheumatoid arthritis; long-term steroid therapy **Setting:** single centre; hospital; UK **Intervention group 1** (bipolar; data available only for analysed participants) • Age, mean (SD): 74.5 (± 3.9) years • Gender, M/F, n: 13/26 • Mobility assessment, independent with aids, n: 30 • Mobility assessment, independent, n: 35 **Intervention group 2** (unipolar; data available only for analysed participants) • Age, mean (SD): 74.4 (± 4.4) years • Gender, M/F, n: 4/30 • Mobility assessment, independent with aids, n: 22 • Mobility assessment, independent, n: 28 **Intervention group 3** (IF; data available only for analysed participants) • Age, mean (SD): 73.4 (± 4.3) years • Gender, M/F, n: 11/26 • Mobility assessment, independent with aids, n: 27 • Mobility assessment, independent, n: 33 **Note:** • study authors did not report: smoking history, BMI, cognitive status, preoperative waiting time
Interventions	**General details:** no details **Intervention group 1** • HA Monk ('hardtop') cemented, bipolar (Johnson & Johnson Orthopaedics, Bracknell, UK)

Calder 1995 *(Continued)*

	• Randomised = unknown **Intervention group 2** • HA Thompson, unipolar, cemented • Randomised = unknown **Intervention group 3** • IF; sliding screw and plate, Ambi Hip screw (Smith & Nephew, Cambridge, UK) • Randomised = unknown **Note:** • study authors only report data for participants who responded to the Nottingham Health Profile questionnaire
Outcomes	**Outcomes measured/reported by study authors:** Nottingham Health Profile (pain, physical mobility, sleep, energy, social, emotion) **Outcomes relevant to the review:** none
Notes	**Funding/sponsor/declarations of interest:** no commercial funding **Study dates:** not reported **Note:** • we did not complete risk of bias assessment because this study reported no relevant review outcomes

Calder 1996

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar

Participants	**Total number of randomised participants:** 250
	
	Inclusion criteria: > 80 years of age; displaced intracapsular fracture (Garden stage III to IV)
	
	Exclusion criteria: mental test score < 5; uncontrolled Parkinson's disease; disseminated malignancy or pathological fracture; Paget's disease involving the proximal femur on the side of the fracture; rheumatoid arthritis; long-term steroid therapy
	
	Setting: single centre; hospital; UK
	
	Intervention group 1 (bipolar)
	
	• Age, median (IQR): 85 (82 to 88) years
	• Gender, M/F, n: 17/101
	• Mobility assessment/use of walking aides:
	  ◦ independent or 1 stick only, n: 85
	  ◦ able to go out alone, n: 55
	  ◦ independent of carers, n: 26
	• Place of residence: "resident in community", n: 100
	• Cognitive status, mental test score, median (IQR): 13 (11 to 13)
	• Fracture classification: all displaced

Calder 1996 *(Continued)*

Intervention group 2 (unipolar)

- Age, median (IQR): 85 (82 to 88) years
- Gender, M/F: 18/114
- Mobility assessment/use of walking aides:
  - independent or one stick only, n: 97
  - able to go out alone, n: 57
  - independent of carers, n: 24
- Place of residence: "resident in community", n: 104
- Cognitive status, mental test score, median (IQR): 12 (10 to 13)
- Fracture classification: all displaced

Note:

- study authors did not report: smoking history, BMI, cognitive status, preoperative waiting time

Interventions	**General details:** all carried out by 1 surgeon; "a Hardinge direct lateral approach was used in the same conventional operating theatre which did not have laminar flow air supply. The prostheses were cemented into the femur with normal viscosity cement in an orthograde manner using a syringe and a vent but no cement restriction"; mobilised fully weight bearing after 24 to 48 hours with assistance from physiotherapists. Outpatient assessment carried out at 6 to 8 weeks, followed by annual reviews **Intervention group 1** • HA Monk ('hardtop') cemented bipolar (Johnson & Johnson Orthopaedics, Bracknell, UK) • Randomised = 118; losses = 51 (37 died at 1 year; other losses are unexplained); analysed = 118 **Intervention group 2** • HA Thompson cemented unipolar (Corin Medical Ltd, Cirencester, UK) • Randomised = 132; losses = 58 (37 died at 1 year; other losses are unexplained); analysed = 132
Outcomes	**Outcomes measured/reported by study authors:** mortality (in hospital; at 2 monthly intervals up to 12 months); return to preoperative place of residence; return to pre-injury state; no limp; no or mild pain; satisfied with operation; HHS; length of hospital stay **Outcomes relevant to the review:** mortality (at 4 and 12 months) **Note:** • we note that the data is an interim report and therefore is not complete for all participants
Notes	**Funding/sponsor/declarations of interest:** no commercial funding **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "computerised random-number generation"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance

Calder 1996 *(Continued)*

Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that the interventions were performed by one surgeon but we could not be certain whether they were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	We noted a large number of deaths, but these were balanced between groups, and we assumed that data were complete for other outcomes. We included data for mobility and pain from an interim report which included fewer participants, and we could not be certain whether this data included attrition
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Cao 2014

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** internal fixation (3 compression screws) vs THA (uncemented)

Participants	**Total number of randomised participants:** 285
	
	Inclusion criteria: people with femoral neck fracture (Garden's III or IV); > 65 years of age; admitted at 1 to 3 days after fracture; in normal mental state, with independent living ability
	
	Exclusion criteria: pathological fractures; preoperative avascular necrosis of the femoral head; osteoarthritis or rheumatoid arthritis; hemiplegia or bedridden for various reasons; other complications affecting hip function. In addition, participants were also excluded because of: cancelled operations due to lack of anaesthesia, lost to follow-up, discontinued, died during surgery
	
	Setting: single-centre; hospital; China
	
	Baseline characteristics
	
	Intervention group 1 (internal fixation)
	
	• Age: 76.8 (65 to 93) years (it was not reported whether these data were mean or median, and range or other distribution value)
	• Gender, M/F, n: 59/69
	• Comorbidities, n:
	  ◦ hypertension: 102
	  ◦ diabetes: 80
	  ◦ coronary heart disease: 36
	  ◦ chronic obstructive lung disease: 41
	• Fracture classification, Gardens III/IV, n: 62/66
	
	Intervention group 2 (THA)
	
	• Age: 75.9 (65 to 94) years (it was not reported whether these data were mean or median, and range or other distribution value)
	• Gender, M/F, n: 73/84

Cao 2014 *(Continued)*

- Comorbidities, n:
  - hypertension: 111
  - diabetes: 114
  - coronary heart disease: 49
  - chronic obstructive lung disease: 37
- Fracture classification, Garden's III/IV, n: 65/92

Overall:

- Gender, M/F, n: 132/153

Note:

- study authors do not report baseline characteristics, by group, for smoking history, medication, BMI, mobility, place of residence, cognitive status, ASA status

Interventions	**General details:** all operations by 1 surgical team ("expert technicians and well experienced"); annual physical and imaging examinations within 5 years after surgery; postoperative follow-up via telephone and written correspondence **Intervention group 1** • IF: closed reduction, and internal fixation with 3 hollow compression screws • number randomised = 128, no reported losses; analysed = 128 **Intervention group 2** • THA: uncemented prosthesis (manufacturer details not reported) • number randomised = 157, no reported losses; analysed = 157 **Note:** • study authors do not report type of anaesthesia, use of prophylactic antithomboembolics or antibiotics, and time to weight bearing • study authors note that 26 participants did not attend follow-up at 2 years because of poor physical health; outcome data from the 1-year follow-up was used for these participants
Outcomes	**Outcomes measured/reported by study authors:** duration of surgery, intraoperative blood loss, length of stay, postoperative complications (decubitis ulcer, pneumonia, DVT, stroke, UTI, deep infection), failure of operation (includes need for re-operation at 5 years), mortality (available at 1, 2, 3, 4, and 5 years, as survival rates in a figure), hip function walking ability, and HHS) **Outcomes relevant to the review:** mortality (12 months), unplanned return to theatre (at 5 years) **Note:** • we did not include data for mortality because it was reported only in a figure from which we could not reliably extract numerical data
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** 2001 to 2005

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method used for randomisation not reported

Cao 2014 *(Continued)*

Allocation concealment (selection bias)	Low risk	Use of identical, sealed, numbered and opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to the intervention. We did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Low risk	Surgeons were experienced and we assumed that experience was equal in the use of both types of interventions
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors reported no losses and we assumed that complete data were reported
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trial registration or prepublished protocol. It is not feasible to effectively assess risk of reporting bias without these documents

Chammout 2012

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** internal fixation (2 cannulated Olmed screws) vs THA (cemented)
Participants	**Total number of randomised participants:** 100 **Inclusion criteria:** acute, displaced, femoral neck fracture (Garden's III or IV) sustained within the previous 36 hours; ≥ 65 years of age; admission from home with no concurrent joint disease or previous fracture involving the lower extremities; healthy status or only mild systemic disease (ASA status I or II); intact cognitive function, ability to carry out all ADL; intact hip function prior to fracture **Exclusion criteria:** pathological fracture, deemed not suitable for a THA by the anaesthesiologist, unsuitable to participate in the trial for any other reason **Setting:** single-centre; hospital; Sweden **Baseline characteristics** **Intervention group 1** (internal fixation) • Age, mean (range): 79 (66 to 90) years • Gender, M/F: 16/41 **Intervention group 2** (THA) • Age, mean (range): 78 (65 to 90) years • Gender, M/F: 5/38

Chammout 2012 *(Continued)*

	Note: • study authors do not report baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, pre-operative waiting time
Interventions	**General details:** all operations performed on day of admission or the following day; performed by 18 surgeons (consultants performed 41 THAs and 47 internal fixation; registrars performed 2 THA and 10 internal fixation); all participants given antithromboembolics (dextran), and antibiotic prophylaxis (cloxacillin); mobilisation to POD1. In THA group, participants could use a high chair and stop using crutches at their own discretion **Intervention group 1** • internal fixation with 2 cannulated screws (Olmed; DePuy/Johnson & Johnson) • number randomised = 57, losses = 49 died at 17 years (some participants lost to follow-up at each available time point, but data are complete for review-relevant outcomes); analysed = 57 **Intervention group 2** • THA with a cemented femoral stem manufactured from a titanium alloy (BiMetric, Biomet UK), with a 28 mm chromium-cobalt head. Acetabular component was also cemented (Müller, Biomet, UK) • number randomised = 43; losses = 37 died at 17 years (some participants lost to follow-up at each available time point, but data are complete for review-relevant outcomes); analysed = 43 **Note:** • study authors do not report type of anaesthesia
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at: 3 months, 1, 2, 4, 11, 17 years); re-operations (and reasons; at 17 years); duration of surgery, amount of blood loss, grading of surgery success, functional status (HHS), hip complications (dislocation; nonunion/mechanical failure; osteonecrosis; deep infection; lateral pain; aseptic loosening; periprosthetic fracture) **Outcomes relevant to the review:** mortality (at 3 months and 17 years); unplanned return to theatre (17 years)
Notes	**Funding/sponsorship/declarations of interest:** no external funding sources **Study dates:** February 1990 to December 1994

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Initial use of sealed envelopes (for 20 participants), but then allocated according to days of the week
Allocation concealment (selection bias)	High risk	It was not feasible to conceal allocation because of methods used to randomise participants to groups
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Quote: "The patients, surgeons, and staff were not blinded to chose [sic] of treatment" Comment: we did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	It is not clear whether surgeons were equally experienced with both types of interventions

Chammout 2012 *(Continued)*

Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant losses were well reported at each time point, and were balanced between groups. Data were complete for review outcomes
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Retrospectively registered with a clinical trials register (NCT01344772; registered on 29 April 2011). It is not feasible to use these documents to effectively assess risk of reporting bias

Chammout 2017

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA: cemented versus uncemented
Participants	**Total number of randomised participants:** 69 **Inclusion criteria:** displaced femoral neck fracture (Garden III–IV); surgery within 48 hours; age 65 to 79 years; no concurrent joint disease or previous fracture in the lower extremities; intact cognitive function (no diagnosis of dementia and at least 7 correct answers on a 10-item SPMSQ); ability to ambulate independently with or without walking aids **Exclusion criteria:** pathological fractures; rheumatoid arthritis; symptomatic osteoarthritis; severe comorbidities; deemed unsuitable for a THA by the anaesthesiologist **Setting:** single centre; hospital; Sweden **Baseline characteristics** **Intervention group 1** (cemented) • Age, mean (SD): 72 (± 4) years • Gender, M/F, n: 12/22 • BMI, mean (SD): 23 (17 to 38) kg/m^2 • ASA status, I or II/III or IV, n: 26/9 • Additional information: ○ Type of femur preoperatively, Dorr Typ A/B/C, n: 12/19/4 **Intervention group 2** (uncemented) • Age, mean (SD): 73 (± 5) years • Gender, M/F, n: 10/25 • BMI, mean (SD): 24 (20 to 34) kg/m^2 • ASA status, I or II/III or IV, n: 17/17

Chammout 2017 *(Continued)*

- Additional information:
  - Type of femur preoperatively, Dorr Typ A/B/C, n: 5/27/2

Notes:

- study authors did not report: smoking history, medication, comorbidities, mobility assessment, place of residence, cognitive status; preoperative waiting time

Interventions	**General details:** 22 surgeons (at consultant or specialist level) who were experienced in both procedures; direct lateral approach; preoperative surgical planning was performed; 32 mm cobalt-chromium head was used in all patients; low-molecular-weight heparin postoperatively for at least 10 days; preoperative antibiotic prophylaxis with cloxacillin (2 g); 3 additional doses during the first 24 hours; patients were mobilised without any restrictions **Intervention group 1** • THA cemented group; modular CPT (Zimmer, Warsaw, IN); proximal femur was reamed with 1 or 2 reams and was then prepared with broaches of increasing size • Randomised = 35 **Intervention group 2** • THA uncemented; Bi-Metric stem (Biomet, Warsaw, IN); femur was reamed until cortical bone contact was obtained; proximal femur prepared with broaches of increasing size; cemented cup • Randomised = 34
Outcomes	**Outcomes measured/reported by study authors:** hip-related complications and re-operations, HRQoL (assessed with EQ-5D index; at 3 months, 12 months, and 24 months); complications: intraoperative and postoperative periprosthetic fracture, dislocations, wound infection (both superficial and deep), early and late loosening, and re-operation of the hip for any reason; at 24 months; mortality and hip function at 3, 12, and 24 months (using HHS; at 3 months, 12 months, and 24 months); pain (using Pain Numerical Rating Score; at 3 months, 12 months, and 24 months); ADL (at 3 months, 12 months, and 24 months); intraoperative bleeding, duration of surgery, and intraoperative vital signs; serological markers of inflammation and thrombosis preoperatively and postoperatively; cardiovascular events; acute heart infarct; cerebral vascular lesions; pulmonary embolism; DVT; heterotopic ossification at 24 months **Outcomes relevant to the review:** unplanned return to theatre; mortality (at 12 months); HRQoL (using EQ-5D). Reported at 3 and 12 months **Notes:** • unplanned return to theatre: reasons for re-operation were excessive migration, subsidence and pain; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsor/declarations of interest:** funding not reported. Study authors declare no conflicts of interest **Study dates:** September 2009 to 2016 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Chammout 2019

Study characteristics	
Methods	RCT; parallel design

Chammout 2019 *(Continued)*

Review comparison group: THA versus HA

Participants	**Total number of randomised participants:** 120
	
	Inclusion criteria: acute displaced femoral neck fracture (Garden III or IV); occurred < 36 hours previously; ≥ 80 years of age; ability to walk independently with or without walking aids; intact cognitive-function with a SPMSQ score of 8 to 10 points
	
	Exclusion criteria: pathological fracture; osteoarthritis; patients with rheumatoid arthritis in the fractured hip; patients who were non-walkers; deemed unsuitable for participation
	
	Setting: single centre; hospital; Sweden
	
	Intervention group 1 (THA)
	
	• Age, mean (SD): 85 (± 4) years
	• Gender, M/F, n: 15/45
	• BMI, mean (SD): 24 (± 4) kg/m^2
	• Mobility assessment, no walking aids or one stick, n: 30
	• Place of residence, independent living, n: 58; serviced building/senior housing, n: 2
	• ASA status, I and II, n: 30; III and IV, n: 30
	• Additional information:
	  ◦ Functional capacity, Charnley A/B/C, n: 46/9/5
	
	Intervention group 2 (HA)
	
	• Age, mean (SD): 86 (± 4) years
	• Gender, M/F, n: 15/45
	• BMI, mean (SD): 25 (± 4) kg/m^2
	• Mobility assessment, no walking aids or one stick, n: 29
	• Place of residence, independent living, n: 57; serviced building/senior housing, n: 3
	• ASA status, I and II, n: 20; III and IV, n 40
	• Additional information:
	  ◦ Functional capacity, Charnley A/B/C, n: 50/4/6
	
	Note:
	
	• study authors report no baseline characteristics for: smoking history, medication, comorbidities, cognitive status, and preoperative waiting time

Interventions	**General details:** performed either by a consultant orthopaedic surgeon or by a registrar with assistance from a consultant; direct lateral approach with the patient in the lateral decubitus position; modular, collarless, polished, tapered cemented femoral component (CPT; Zimmer) was used until 2014 - changed to an anatomically shaped cemented stem (Lubinus SP2; Waldemar Link); vacuum-mixed low-viscosity cement with gentamicin (Palacos with gentamicin; Schering-Plough) was used in all patients; antibiotic and anticoagulant prophylaxis, weight bearing the day after surgery **Intervention group 1** • THA; cemented 32 mm cobalt-chromium head; cemented highly cross-linked polyethylene acetabular component • Randomised = 60; losses = 8 (4 died; 4 withdrew); analysed for mortality and unplanned return to theatre = 60; analysed for HRQoL at 3 months = 57; analysed for HRQoL at 12 months = 56 **Intervention group 2** • HA; cemented unipolar head replacement, CPT Zimmer • Randomised = 60; losses = 13 (4 died; 9 withdrew) analysed for mortality and unplanned return to theatre = 60; analysed for HRQoL at 3 months = 54; analysed for HRQoL at 12 months = 50 **Note:**

Chammout 2019 *(Continued)*

	• study investigators changed the type of design used during study period
Outcomes	**Outcomes measured/reported by study authors:** HHS, HRQoL (EQ-5D), Pain Numerical Rating score, ADL (available at 3, 12, and 24 months), mortality (at 24 months); surgical time, intraoperative bleeding, ability to regain previous walking function (at 2 years); adverse events, including cardiovascular events (at 2 years): dislocation, superficial infection, deep periprosthetic infection, non-healing fracture, total number of hip complications, number of patients with re-operation, closed reduction, surgical debridement, another major re-operation, pneumonia, pulmonary embolism, myocardial infarct, cerebrovascular lesion, acute kidney failure **Outcomes relevant to the review:** HRQoL (using EQ-5D utility index - VAS not reported; at 3 months and 12 months); unplanned returned to theatre (24 months); mortality (24 months) **Notes:** • unplanned return to theatre: reasons for re-operation were dislocation and infection; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsor/declarations of interest:** funded by grants from the regional agreement on medical training and clinical research (ALF) between Stockholm County Council and Karolinska Institutet **Study dates:** September 2009 to 2018; recruitment September 2009 to April 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Use of block randomisation
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes; however, study authors do not report if envelopes are opaque and sequentially numbered and we have therefore judged that there is insufficient information
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to the intervention. We did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	It is not clear if surgeons were equally experienced with both types of interventions
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Participants blinded to intervention
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most participant loss was because of death, which is expected in this population. Other losses (owing to participants that withdrew from the study) were relatively balanced between groups

Chammout 2019 *(Continued)*

Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Protocol published in 2015, and retrospective clinical trials registration in 2014 (NCT02246335; first received September 2014). Because the study started in 2009, it is not feasible to effectively assess risk of selective reporting bias with these documents

Christie 1988

Study characteristics	
Methods	RCT; parallel group **Review comparison group:** smooth pin versus fixed angle plate
Participants	**Total number of randomised participants:** 127 **Inclusion criteria:** < 80 years of age; displaced subcapital fractures of the neck of femur which were all Garden Grade III or IV; fracture could be adequately reduced according to Garden's criteria; non-pathological other than as a result of osteoporosis **Exclusion criteria:** not reported **Setting:** hospital; single centre; UK **Baseline characteristics** **Intervention group 1** (double pin) • Age, 26 to 65 years, n: 16 • Age, 66 to 74 years, n 26 • Age, 75 to 80 years, n: 24 • Mobility assessment: all able to walk independently before their fracture • Fracture classification: all displaced **Intervention group 2** (sliding screw) • Age, 26 to 65 years, n: 24 • Age, 66 to 74 years, n: 18 • Age, 75 to 80 years, n: 19 • Mobility assessment: all able to walk independently before their fracture • Fracture classification: all displaced **Note:** • study authors did not report the following baseline characteristics: gender, smoking history, medication, BMI, comorbidities, place of residence, cognitive status, ASA status, preoperative waiting time. However, study authors report that the groups "were equally matched on all parameters measured except age"
Interventions	**General details:** surgery performed under spinal or general anaesthetic, within 24 hours of admission where possible. Participants mobilised to full weight bearing. **Intervention group 1** • Double divergent pin fixation (McQuillan 1973) • Randomised = 66; losses = unknown (overall 8 were lost to follow-up but does not specify to which groups these belonged); analysed = 66

Christie 1988 *(Continued)*

	Intervention group 2 • Sliding screw fixation (Clawson 1964) • Randomised = 61; losses = unknown (overall 8 were lost to follow-up but does not specify to which groups these belonged, and number of losses does not tally with data reported for mobility); analysed = 61 **Notes:** • study authors did not report the following intervention details: number of clinicians (and their skill or experience), use of prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors**: mortality; deep infection; AVN; non-union; mobility; revision surgery **Outcomes relevant to the review:** unplanned return to theatre (revision surgery; time point not reported) **Note:** • we did not report data for mortality because study authors did not clearly explain losses or specify the numbers in each group for these outcome data • unplanned return to theatre: reasons for re-operation deep infection; types of re-operation were not reported
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Patients were randomly allocated to one of two treatment groups" Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were experienced in both techniques
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors reported overall numbers lost of follow-up (rather than numbers lost per group) and we therefore could not include data for some outcomes. However, for remaining outcomes, data were complete
Other bias	Low risk	We identified no other sources of bias

Christie 1988 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Cornell 1998

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar
Participants	**Total number of randomised participants:** 48 **Inclusion criteria:** displaced femoral neck fracture **Exclusion criteria:** < 65 years; previous surgery involving the fractured hip; pathological fracture; life expectancy < 1 year; inability to make competent decisions regarding healthcare **Setting:** single centre; hospital; Sweden **Baseline characteristics** **Intervention group 1** (bipolar) • Age, mean (SD, range): 78.0 (± 8, 67 to 97) years • Gender, M/F: 8/25 • Cognitive status/dementia, mini-mental score, mean (SD, range): 24.0 (± 4, 6 to 30) • Hip Rating Score, mean (SD): 45.6 (± 11, 31 to 75) • Fracture classification: 100% displaced **Intervention group 2** (unipolar) • Age, mean (SD): 77.6 (± 10) (range 62 to 91) years • Gender, M/F: 4/11 • Cognitive status/dementia, mini-mental score: mean (SD, range): 24.5 (± 5, 20 to 30) • Hip Rating Score, mean (SD, range): 52.8 (± 11, 36 to 69) • Fracture classification: 100% displaced **Note:** • study authors did not report baseline characteristics on smoking history, medication, BMI, mobility assessment, comorbidities, place of residence
Interventions	**General details:** all performed through posterior approach with a cemented modular femoral component; preoperative antibiotics; spinal or general anaesthetic; postoperative thromboembolic prophylaxis; weight bearing where tolerated; postoperative clinical follow-up at 6 weeks, 3 months and 6 months **Intervention group 1** • Bipolar; cemented modular femoral component (Orthopaedic Devices Corporation, Allendale, USA) • Randomised = 33; losses = 2 (owing to death); analysed = 33 **Intervention group 2** • Unipolar; cemented modular femoral component (Orthopaedic Devices Corporation, Allendale, USA) • Randomised = 15; losses = 1 (owing to death); analysed = 15

Cornell 1998 *(Continued)*

Outcomes	**Outcomes measured/reported by study authors:** postoperative complications: dislocation; range of motion; length of hospitalisation; cost of prosthesis; operative time; estimated blood loss; functional (Johansen hip score); 6MWT; Get Up and Go test **Outcomes relevant to the review:** mortality (at 6 months)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** study started in July 1996; finish date not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Random generated order with sealed envelopes, opened prior to anaesthesia; method of randomisation not clearly explained. We noted an uneven number of participants in each group, which could indicate that the method of randomisation was not adequate
Allocation concealment (selection bias)	Unclear risk	Sealed envelopes; study authors do not state whether envelopes are opaque and sequentially numbered and we have therefore judged that there is insufficient information
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participants blinded. It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Dalen 1985

Study characteristics

Methods	RCT; single centre; parallel design **Review comparison group:** smooth pin (Thornton nail) versus smooth pin (Scand hip pin)
Participants	**Total number of randomised participants:** 103 **Inclusion criteria:** intracapsular fractures of the femoral neck

Dalen 1985 *(Continued)*

	Exclusion criteria: abnormalities in the opposite hip **Setting:** single centre; hospital; Sweden **Baseline characteristics (overall)** • Age, mean (SD): 79 (± 11) years • Gender, M/F: 25/78 **Note:** • study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, medication, BMI, comorbidities, mobility assessment/use of walking aides, place of residence, cognitive status/dementia, ASA status, preoperative waiting time, fracture classification
Interventions	**General details:** all staff were used to perform surgery irrespective of experience; displaced fractures were treated with pin traction before operation; extension fracture table and biplane fluoroscopy used for reduction; full weight bearing was allowed; general or epidural anaesthetic **Intervention group 1** • Single Thornton nail (no plate described) • Number randomised to group is not reported **Intervention group 2** • 3 Scand hip pins • Number randomised to group is not reported
Outcomes	**Outcomes measured/reported by study authors:** re-operation **Outcomes relevant to the review:** unplanned return to theatre (12 months); followed up at mean 12.6 (± 4.5) months **Note:** • 72 described as receiving successful primary operations, 31 = nail and 41 = pin • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were not reported
Notes	**Funding/sponsor/declarations of interest:** financially supported by"Forskningsoch Utvekclingsarbete inom Lässjukvarden i Skaraborgs Län" **Study dates:** January 1983 to April 1985 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Davison 2001

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar versus internal fixation
Participants	**Total number of randomised participants:** 277

Davison 2001 *(Continued)*

Inclusion criteria: displaced intracapsular fracture of the proximal femur; aged 65 to 79 years

Exclusion criteria: AMTS < 5/13; uncontrolled Parkinson's disease; pathological fracture; disseminated malignancy; Paget's disease; rheumatoid arthritis; long-term steroid therapy

Setting: single centre; hospital; UK

Baseline characteristics

Intervention group 1 (bipolar)

- Age, median (IQR): 75 (71 to 78) years
- Gender, M/F, n: 25/72
- Mobility assessment/use of walking aides, n:
  - independent of aids: 66
  - independent in mobility: 74
- Place of residence, living independently, n: 91
- Cognitive status/dementia, mental test score, median (IQR): 13 (12 to 13)
- Preoperative waiting time after admission, median (IQR): 2 (1 to 3) days

Intervention group 2 (unipolar)

- Age, median (IQR): 76 (72 to 77) years
- Gender, M/F, n: 19/71
- Mobility assessment/use of walking aides, n:
  - independent of aids: 55
  - independent in mobility: 69
- Place of residence, living independently, n: 83
- Cognitive status/dementia, mental test score, median (IQR): 13 (13 to 13)
- Preoperative waiting time after admission, median (IQR): 2 (1 to 3) days

Intervention group 3 (internal fixation)

- Age, median (IQR): 73 (70 to 77) years
- Gender, M/F, n: 23/70
- Mobility assessment/use of walking aides, n:
  - independent of aids: 67
  - independent in mobility: 79
- Place of residence, living independently, n: 87
- Cognitive status/dementia, mental test score, median (IQR): 13 (13 to 13)
- Preoperative waiting time after admission, median (IQR): 2 (1 to 2) days

Note:

- study authors did not report any baseline data for: smoking history, medication or BMI

Interventions	**General details:** lateral (Hardinge) approach; identical collar-and-stem profiles; methylmethacrylate cement; immediate weight bearing; clinical follow-up at 6 weeks, then annually for 5 years - a home assessment was carried out annually by a research occupational therapist who was blind to the participant's operative treatment **Intervention group 1** • HA bipolar; cemented Monk (hard-top) HA • Randomised = 97; losses = 21 (owing to death); analysed = 97 **Intervention group 2** • HA unipolar; cemented Thompson HA • Randomised = 90; losses = 25 (owing to death); analysed = 90

Davison 2001 *(Continued)*

	Intervention group 3 • IF; AMBI compression hip screw and a two-hole plate (Smith & Nephew Richards, Cambridge, UK) • Randomised = 93; losses = 18 (owing to death, at 36 months); analysed = 93;
Outcomes	**Outcomes measured/reported by study authors:** verbally-conducted functional assessment questionnaire, in addition to HHS (HHS; data available at 1, 2, 3, 4, and 5 years); loosening and subsidence; mortality (data available at 6, 12, 18, 24, 30, and 36 months); revision (data available at 6, 12, 18, 24, 30, and 36 months); Barthel Index; return to pre-injury state, patient satisfaction **Outcomes relevant to the review:** mortality (at 12 months and 36 months); unplanned return to theatre **Notes:** • unplanned return to theatre: reasons for re-operation were dislocation, pain, acetabular wear and infection; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsor/declarations of interest:** no funding from commercial funding; study report states that "benefits have been or will be received but will be directed solely to a research fund, foundation, educational institution, or other non-profit organisation with which one or more of the authors are associated" **Study dates:** January 1991 to January 1996

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "computer generation of random numbers"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias

Davison 2001 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

DeAngelis 2012

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented

Participants	**Total number of randomised participants:** 130
	
	Inclusion criteria: > 55 years; nonpathologic displaced femoral neck fracture; scheduled for HA by the attending orthopaedic surgeon; able to ambulate 10 feet before presentation
	
	Exclusion criteria: multiple extremity trauma; clinically recognised acute MI within 30 days before enrolment; anaemia; pre-existing metabolic bone disease
	
	Setting: single centre; hospital; USA
	
	Baseline characteristics
	
	Intervention group 1 (cemented)
	
	• Age, mean (SD): 81.8 (± 9.0) years
	• Gender, M/F, n: 14/52
	• BMI, mean (SD): 24.2 (± 4.4) kg/m^2
	• Place of residence, lived at home: 75.8%
	• ASA status, I to III, n: 54; IV, n: 12
	• Co-morbidities, n:
	  ○ cardiovascular disease: 26
	  ○ dementia: 12
	  ○ coronary artery disease: 12
	  ○ diabetes: 9
	  ○ congestive heart failure: 8
	  ○ chronic lung disease: 12
	  ○ cerebrovascular disease: 4
	  ○ peripheral vascular disease: 2
	• Fracture classification: 100% displaced
	
	Intervention group 2 (uncemented)
	
	• Age, mean (SD): 82.8 (± 9.0) years
	• Gender, M/F, n: 16/48
	• BMI, mean (SD): 23.6 (± 3.9) kg/m^2
	• Place of residence, living at home, n: 81.3%
	• ASA status, I to III, n: 56; IV, n: 8

DeAngelis 2012 *(Continued)*

- Co-morbidities, n:
  - cardiovascular disease: 26
  - dementia: 14
  - coronary artery disease: 13
  - diabetes: 10
  - congestive heart failure: 9
  - chronic lung disease: 8
  - cerebrovascular disease: 6
  - peripheral vascular disease: 1
- Fracture classification: 100% displaced

Overall

- Age; mean (SD, range): 82.3 (± 8.3, 55 to 100) years
- Gender, M/F: 30/100
- BMI, mean (SD, range): 23.8 (± 4.1, 15.9 to 37.6) kg/m^2
- Place of residence, lived at home, n: 78.5%
- ASA status, I to III, n: 84.6%
- Fracture classification, undisplaced/displaced: 100% displaced

Note:

- study authors did not report any baseline data for: smoking history, medication, cognitive status/dementia, preoperative waiting time

Interventions	**General details:** performed by the attending orthopaedic surgeon; spinal or general anaesthetic; placed in the lateral decubitus position, and a standard anterolateral or posterolateral approach was used; all patients received a unipolar head; all patients were allowed to weight bear to tolerance **Intervention group 1** • HA cemented; femoral prosthesis (VerSys LD/Fx; Zimmer, Warsaw), unipolar • Randomised = 66; losses at 12 months = 12 (owing to death); analysed = 66 **Intervention group 2** • HA uncemented; femoral prosthesis (VerSys Beaded FullCoat; Zimmer, Warsaw), unipolar • Randomised = 64; losses at 12 months = 10 (owing to death); analysed = 64
Outcomes	**Outcomes measured/reported by study authors:** functional outcome at 1 year; IADL and PADL scales were obtained using a modified version of the Older Americans Resources and Services Instrument; mortality (in hospital and at 30 days, 60 days, and 1 year); postoperative unstable angina, and MI; unstable angina; pneumonia, wound infection, thromboembolism, and stroke; ability to walk independently; discharge destination; functional outcome questionnaire was completed by telephone at 30 days, 60 days, and 1 year. **Outcomes relevant to the review:** mortality (at 60 days, and 1 year)
Notes	**Funding/sponsor/declarations of interest:** supported by a restricted research grant from Zimmer, Inc (Warsaw, IN). Funds allocated to hospital costs associated with randomisation (implants and surgical supplies), and not for salary costs **Study dates** March 2005 and May 2008

Risk of bias

Bias	Authors' judgement	Support for judgement

DeAngelis 2012 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Described as randomised but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that the interventions were all performed by orthopaedic surgeons but we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Loss of participants is owing to death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study is retrospectively registered with a clinical trials register (NCT01114646; first posted in May 2010). It was not feasible to use these retrospective documents to assess risk of selective reporting bias

Dolatowski 2019

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** internal fixation (2 cannulated screws) vs HA
Participants	**Total number of randomised participants:** 219 **Inclusion criteria:** ≥ 70 years of age, admitted to any of the 3 trial centres because of femoral neck fracture; able to walk, resided in hospital's catchment area, radiographically confirmed nondisplaced, intracapsular femoral neck fracture **Exclusion criteria:** displaced femoral neck fracture, ASA IV, pre-existing ipsilateral femoral implant, infection in the hip or pelvic area or sepsis, acute confusion without a history of dementia, concomitant pelvic fracture, or pathological fracture; unable to walk **Setting:** multi-centre; 3 hospitals; Norway **Baseline characteristics** **Intervention group 1** (internal fixation, IF)

Dolatowski 2019 *(Continued)*

- Age, mean (SD): 83.2 (± 6.8) years
- Gender, M/F: 27/84
- Smoking history, current or former smoker, n: 40
- Comorbidities, Charlson comorbidity index, mean (SD): 5.7 (± 1.5)
- Mobility assessment, walks without any aids, n: 51
- Place of residence, living at home, n: 74
- ASA status, I or II, n: 40
- Pre-operative waiting time, mean (SD): 29 (± 21) hours

Intervention group 2 (HA)

- Age, mean (SD): 83.1 (± 6.6) years
- Gender, M/F: 35/73
- Smoking history, current or former smoker, n: 38
- Comorbidities, Charlson comorbidity index, mean (SD): 5.5 (± 1.5)
- Mobility assessment, walks without any aids, n: 58
- Place of residence, living at home, n: 87
- ASA status, I or II, n: 43
- Pre-operative waiting time, mean (SD): 28 (± 19) hours

Note:

- study authors do not report baseline characteristics for medication, BMI, cognitive status

Interventions	**General details:** all participants received perioperative antibiotics and antithrombotic prophylaxis; physiotherapists provided instructions for mobilisation, including weight bearing as tolerated; use of spinal anaesthesia in the internal fixation group, type of anaesthesia in the HA group is not reported **Intervention group 1:** • IF; 2 partially threaded, cancellous, cannulated screws of 8 mm diameter (Hip Pins; Smith & Nephew) • number randomised = 111 **Intervention group 2:** • HA; type of implant depended on the centre. All used latest-generation implant, with or without bone cement. In the main centre: Exeter stem (V40; Stryker) with a modular head inserted with bone cement through direct lateral approach. In the 2nd centre: cementless CORAIL stem (DePuy/Johnson & Johnson) with a modular head through direct lateral approach. In the 3rd centre: cementless CORAIL stem (DePuy/Johnson & Johnson) with a modular head through posterior approach until January 2014, and then using same prosthesis and approach as main centre • number randomised = 108 **Note:** • study authors do not specify number of clinicians and their skills and experience
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 1, 3, 12, and 24 months); major re-operations; minor and moderate re-operations; HRQoL (using EQ-5D; available at 3, 12, 24 months); surgical complications (fixation failure or nonunion, osteonecrosis, deep infection, dislocation of HA, drop foot, peri-implant fracture; hip function (HHS); mobility (TUG); hip pain (Pain Numerical Rating Score) **Outcomes relevant to the review:** mortality (3 months and 12 months); unplanned return to theatre (major; and minor and moderate re-operations) HRQoL (using EQ-5D, at 3 months and 12 months)
Notes	**Funding/sponsorship/declarations of interest:** funding from Akershus University Hospital and Sophies Minde, Norway. One author has received personal fees from Zimmer Biomet, unrelated to this study

Dolatowski 2019 *(Continued)*

Study dates: 6 February 2012 to 6 February 2015

Note:

- we did not complete a risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Dorr 1986

Study characteristics

Methods

Quasi-RCT; parallel design

Review comparison group: THA versus HA: cemented versus uncemented

Note:

- participants were randomised in the first year to THA vs cemented HA, and in the second year to THA vs uncemented HA. We combined data in the HA groups where possible, and compared these data to THA. We did not use data for cemented HA vs uncemented HA because participants were not randomised directly to these two intervention groups

Participants

Total number of randomised participants: 89

Inclusion criteria: oriented and ambulatory patients (classes 1 and 2); Garden type III or IV

Exclusion criteria: < 55 years of age (apart from 5 included younger patients); "totally confused and nonambulatory patients"

Setting: single centre; hospital; USA

Baseline characteristics

Intervention group 1 (THA)

- Age, mean (range): 72 (53 to 89) years
- Gender, M/F: 11/26
- Cognitive status/dementia, n:
  - ambulatory, alert and orientated: 27
  - ambulatory, periods of confusion but orientated to time, place, person: 12

Intervention group 2 (HA cemented)

- Age, mean (range): 69 (51 to 87) years
- Gender, M/F: 16/23
- Cognitive status/dementia, n:
  - ambulatory, alert and orientated: 32
  - ambulatory, periods of confusion but orientated to time, place, person: 7

Intervention group 3 (HA uncemented)

- Age, mean (range): 66 (41 to 85) years
- Gender, M/F: 4/9
- Cognitive status/dementia, n:
  - ambulatory, alert and orientated: 11
  - ambulatory, periods of confusion but orientated to time, place, person: 2

Overall

- Age; mean (range): 69 (41-89) years

Dorr 1986 *(Continued)*

- Gender, M/F: 31/58
- Cognitive status/dementia, n:
  - ambulatory, alert and orientated: 70
  - ambulatory, periods of confusion but orientated to time, place, person: 19

Note:

- study authors did not report any baseline data for: smoking history, BMI, medication, mobility assessment, place of residence, cognitive status, preoperative waiting time

Interventions	**General details:** performed through a posterior approach; capsule and external rotators were re-attached; antibiotics for 72 hours, aspirin for thromboembolism prophylaxis, and progressive ambulation beginning on the second day after operation **Intervention group 1** • THA; a 28 mm head size was used • Randomised = 39; losses not reported; analysed = 39 **Intervention group 2** • HA cemented, bipolar; the ball size was matched anatomically • Randomised = 37; losses not reported; analysed = 37 **Intervention group 3** • HA uncemented, bipolar; the ball size was matched anatomically • Randomised = 13; losses not reported; analysed = 13 **Note:** • loss to follow-up is unclear, and we have assumed that data were available for the review outcomes for all randomised participants
Outcomes	**Outcomes measured/reported by study authors:** mortality; infections; re-operation; dislocation; modified d'Aubigne and Postel hip score (D'Aubigne 1954); heterotopic ossification; progressive femoral and acetabular cement-bone demarcation; subsidence; calcar resorption; calcar sclerosis; gait analysis; not walking at final follow-up; pain and ambulation (available at 3, 12, and 24 months) **Outcomes relevant to the review:** mortality; unplanned return to theatre (re-operation and dislocations; between 2 and 4 years) **Notes:** • we did not report data for mortality because it was not reported by intervention group • unplanned return to theatre: reasons for re-operation dislocation and heterotopic ossification; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsor/declarations of interest:** supported by grants from the Canadian Institutes of Health Research, the National Institutes of Health, ZorgOnderzoek Nederland-Medische Wetenschappen, Sphies Minde Foundation for Orthopaedic Research, McMaster Surgical Associates, and Stryker Orthpaedics **Study dates** March 1980 and July 1992

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomisation based on odd or even hospital numbers

Dorr 1986 *(Continued)*

Allocation concealment (selection bias)	High risk	It is not feasible to conceal allocation because of the quasi-randomised methods used to allocate participants to groups
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	We could not be certain whether data were complete because numbers of losses were not reported. However, in analysis, we assumed complete data
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

El-Abed 2005

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** internal fixation vs HA (uncemented)
Participants	**Total number of randomised participants:** 122 **Inclusion criteria:** ≥ 70 years of age, with Garden's III and IV intracapsular fractures of neck of femur **Exclusion criteria:** Garden's I or II, pathological fractures, mental confusion, bedridden **Setting:** single-centre; hospital; Ireland **Baseline characteristics (only for participants who survived to end of follow-up)** **Intervention group 1** (internal fixation) • Age, mean (range): 72 (70 to 84) years • Gender, M/F: 18/42 **Intervention group 2** (HA) • Age, mean (range): 74 (70 to 87) years • Gender, M/F: 22/40 **Note:** • study authors do not report baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, ASA status, preoperative waiting times

El-Abed 2005 *(Continued)*

	• it was unclear how many participants were included in the baseline data table, so number of male participants is not reported
Interventions	**General details:** 3 doses of prophylactic antibiotics, and treatment with low-molecular-weight heparin; physical therapy on POD2 and ambulation progressed as tolerated; minimum follow-up of 3 years **Intervention group 1:** • internal fixation with a dynamic hip screw (AO Synthes) through a standard lateral approach. Reduction achieved using manual manipulation and maintained using a fracture table • number randomised = 72; losses = 12 (12 died; 0 lost to follow-up); analysed for mortality = 72; analysed for other outcomes = 60 **Intervention group 2:** • standard anterolateral approach with an uncemented Austin-Moore prosthesis (Howmedica, Rutherford, NJ) • number randomised = 84; losses = 22 (22 died; 0 lost to follow-up); analysed for mortality = 84; analysed for HRQoL and unplanned return to theatre = 62 **Note:** • study authors do not report number of clinicians (or their skills and experience), or type of anaesthesia • study authors reported overall mortality, and mortality in the HA group. We were able to determine the numbers originally allocated to each group using these data
Outcomes	**Outcomes measured/reported by study authors:** mortality (at 3 years); conversion to THA; HRQoL (using SF-36; at end of follow-up); functional status (using Matta Scoring System) **Outcomes relevant to the review:** mortality (at 3 years); unplanned return to theatre (conversion to THA); HRQoL (SF-36, at 3 years)
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** 1994 to 1998

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomised according to hospital admission date
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation because of methods used to randomise participants to groups
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not feasible to blind personnel to intervention groups. We did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors do not report the skills and experience of clinicians and it is unclear whether they were equally experienced with the types of interventions
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data

El-Abed 2005 *(Continued)*

Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors reported no loss to follow-up. Other losses all caused by death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trial registration; it is not feasible to effectively assess risk of reporting bias without these documents

Elmerson 1988

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** smooth pin versus smooth pin
Participants	**Total number of randomised participants:** 263 **Inclusion criteria:** people with femoral neck fracture **Exclusion criteria:** where fracture reduction was not possible **Setting:** single centre; hospital; Sweden **Baseline characteristics (overall)** • Age, mean (range): women 79 (34 to 98) years; men 72 (18 to 95) years • Gender, M/F: 185/78 **Note:** • study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, BMI, medication, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, fracture classification, preoperative waiting time
Interventions	**General details:** 29 surgeons (9 had performed more than 10 operations each); extension table, reduced by the closed method using fluoroscopy; spinal anaesthesia; all participants who had been ambulatory prior to fracture were mobilised on POD1 with the aid of frames or crutches - full weight bearing allowed; no prophylactic antibiotics or anticoagulants, prophylactic for thrombosis was provided **Intervention group 1** • Rydell four-flanged nail • Number randomised to group is unclearly reported **Intervention group 2** • Gouffon pins; three or four pins were used • Number randomised to group is unclearly reported
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 12 and 24 months); fracture failure rate and re-operation at 24 months; redisplacement/non-union; segmental collapse

Elmerson 1988 *(Continued)*

Outcomes relevant to the review: mortality (12 months)

Note:

- we did not include data for non-union because these were combined with data for redisplacement
- we did not include data for re-operation because data for this outcome were unclearly reported

Notes

Funding/sponsor/declarations of interest: financial support was provided by the Trygg-Hansa Foundation, the Gothenburg Medical Society, the Swedish Society of Medicine, and the Tore Nilsson Foundation

Study dates: November 1982 to October 1983

Note:

- we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Elmerson 1995

Study characteristics

Methods

RCT; parallel design

Review comparison group: smooth pin versus fixed angle plate

Participants

Total number of randomised participants: 265

Inclusion criteria: people with femoral neck fracture

Exclusion criteria: not reported

Setting: single centre; hospital; Sweden

Baseline characteristics

Baseline characteristics (overall)

- Age, mean (range): male 78 (50 to 99) years; female 74 (50 to 94) years
- Gender, M/F: 66/199

Intervention group 1 (hook pins; analysed participants)

- Gender, M/F: 46/76
- Fracture classification, undisplaced/displaced: 61/61

Intervention group 2 (sliding screw plate; analysed participants)

- Gender, M/F: 25/75
- Fracture classification, undisplaced/displaced: 38/62

Note:

- study authors did not report other baseline characteristics by group, nor reported any baseline data for: smoking history, BMI, medication, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, preoperative waiting time

Interventions

General details: 24 surgeons (group 1), 29 surgeons (group 2) (experience level not reported); tibia pin traction for displaced fractures; internal fixation; most operated on within 24 hours; fracture table; spinal anaesthesia; full weight bearing day after operation; antithrombotic prophylaxis prescribed for 1/2 weeks; no prophylactic antibiotics;

Elmerson 1995 *(Continued)*

Intervention group 1

- 2 Hansson Hook Pins
- Number randomised to each group was not reported. Losses for re-operation = 26 (3 lost to follow-up, 23 died); number analysed for mortality = 122; number analysed for re-operation = 96

Intervention group 2

- Sliding screw plate
- Number randomised to each group was not reported. Losses for re-operation = 26 (6 lost to follow-up, 20 died); number analysed for mortality = 100; number analysed for re-operation = 74

Outcomes	**Outcomes measured/reported by study authors:** mortality (12 and 24 months); healing complications were recorded as early redisplacement (within 3 months), non-union, segmental collapse **Outcomes relevant to the review:** mortality (12 months); unplanned return to theatre **Note:** • the time point for the data for re-operation was not specified, and we assumed from other information in the study report that it was reported for 24 months • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty, removal of fixation or resection of femoral head
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** 1984 to 1985 (months not reported)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number table used
Allocation concealment (selection bias)	Unclear risk	No description of concealment
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report the numbers of surgeons who used each type of implant. However, study authors do not describe whether surgeons were equally experienced with both implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses are owing to death, which is expected in this population

Elmerson 1995 *(Continued)*

Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration; it is not feasible to effectively assess risk of selective reporting bias without these documents

Emery 1991

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 53 **Inclusion criteria:** displaced subcapital fracture of the femoral neck **Exclusion criteria:** admitted from nursing homes or from other hospitals; use > 1 stick to walk **Setting:** single centre; hospital; UK **Intervention group 1** (cemented) • Age, mean (SD, range): 78 (± 7.2, 63 to 90) years • Gender, M/F, n: 3/24 • Mobility assessment, used 1 walking stick, n: 2 • Place of residence, lived alone/with family/sheltered accommodation, n: 14/9/4 • Fracture classification, n: 100% displaced **Intervention group 2** (uncemented) • Age, mean (SD; range): 76.9 (± 8; 61 to 96) years • Gender, M/F, n: 4/22 • Mobility assessment, used 1 walking stick, n: 4 • Place of residence, lived alone/with family/sheltered accommodation, n: 12/10/4 • Fracture classification, n: 100% displaced **Note:** • study authors did not report any baseline data for: smoking history, medication, cognitive status/dementia, preoperative waiting time
Interventions	**General details:** operations performed by same group of junior staff; Monk duoplet design; patients were mobilised partial weight bearing using crutches or a frame; full weight bearing allowed when comfortable (2 or 3 months) **Intervention group 1** • HA cemented; Thompson stem (bipolar), Monk duoplet design (Johnson & Johnson, England) • Randomised = 27; losses = 8 (owing to death); analysed = 27 **Intervention group 2** • HA uncemented; Moore stem (bipolar), Monk duoplet design (Johnson & Johnson, England) • Randomised = 26; losses = 6 (owing to death); analysed = 26 **Note:**

Emery 1991 *(Continued)*

	• interventions are traditionally unipolar but a bipolar articulation was added
Outcomes	**Outcomes measured/reported by study authors:** complications: pulmonary embolus, wound infection, chest infection, bedsore, renal failure secondary to a gastro-intestinal bleed, urinary tract infection, aortic aneurysm; mortality (at 2 weeks, 3 months, 17 months); pain (measured as presence of any pain); increased dependency on walking aids; change in residential setting (moved to more supportive accommodation) **Outcomes relevant to the review:** mortality (3 months and 17 months) **Notes:** • follow-up at 17 and 18 months for cemented and uncemented groups respectively
Notes	**Funding/sponsor/declarations of interest:** no funding from commercial funding; study report states that "benefits have been or will be received but will be directed solely to a research fund, foundation, educational institution, or other non-profit organisation with which one or more of the authors are associated" **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "At the time of the operation a randomised card was drawn from a sealed envelope; this decided whether each patient had an uncemented bipolar hemiarthroplasty with an Moore stem, or a cemented prosthesis with a Thompson stem" Comment: study authors do not report method used to ensure that cards are randomised
Allocation concealment (selection bias)	Unclear risk	Sealed envelopes. Study authors do not report whether envelopes are numbered or opaque and we have therefore judged that there is insufficient information
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that the interventions were all performed by junior staff; we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Eschler 2014

Study characteristics	
Methods	Quasi-RCT; single centre; parallel design **Review comparison group:** fixed angle plate versus fixed angle plate
Participants	**Total number of randomised participants:** 52 **Inclusion criteria:** displaced and undisplaced femoral neck fractures receiving head-preserving fracture fixation; < 65 years of age and frail adults > 65 years of age **Exclusion criteria:** pathological fractures, multiple trauma and inability to walk independently prior to injury **Setting:** single centre; hospital; Germany **Baseline characteristics** **Intervention group 1** (Targon Femoral Nail implant) • Age: < 65 years of age, n: 12 • Fracture classification: AO 31: B 1.1: 0; B1.2: 11; B1.3: 0; B2.1: 1; B2.2: 6; B2.3: 1; B3.1: 1; B3.2: 2; B3.3: 5 **Intervention group 2** (sliding hip screw) • Age: < 65 years of age, n: 11 • Fracture classification: AO 31: B 1.1: 1; B1.2: 12; B1.3: 3; B2.1: 3; B2.2: 2; B2.3: 2; B3.1: 0; B3.2: 1; B3.3: 1 **Overall** • Age, mean (range): 67.3 (30 to 94) years **Note:** • study authors did not report any baseline data for: smoking history, BMI, mobility assessment, place of residence, cognitive status, preoperative waiting time • we noted that injury was caused by a road traffic accident in 25% participants, and caused by a fall in domestic surroundings in 75% participants
Interventions	**General details:** 1 of 6 experienced senior registrars; reduction of displaced fractures by traction and internal rotation; early postoperative mobilisation with free hip movement and full weight bearing, except for young adults who were limited to partial weight bearing for 6 weeks. Until full mobilisation, given 5000 IU of low-molecular-weight heparin per day; surgery with 24 hours; 500 IU of low-molecular-weight heparin per day **Intervention group 1** • Targon Femoral nail implant - a plate with 6 locking screw ports; 2 distal holes are used to fix the plate to the proximal femoral shaft with 4.5 mm fixed angular screws and 3 to 4 proximal holes for 6.5 mm • Randomised = 27 **Intervention group 2** • Sliding hip screw - a lag screw and an extramedullary load-carrier, which is fixed to the proximal femoral shaft via screws allowing guided subsidence along the axis of the femoral neck • Randomised = 25 **Note:**

Eschler 2014 *(Continued)*

	• mean follow-up time was 15.5 (± 10) months (range 7 to 36); 7 had died in this time but not reported by group
Outcomes	**Outcomes measured/reported by study authors:** functional hip assessment and HHS; pain; radiographic comparisons (postoperative subsidence of the fracture, screw malpositioning, lateral screw back-out, screw cut out, acetabular penetration and location within the femoral neck fragment); re-operation (hip replacement owing to: femoral head necrosis; central perforation; and infected non-union); length of stay in hospital; mortality (at 30 days; not reported by intervention group); discharge destination (to inpatient rehabilitation programme); mobility **Outcomes relevant to the review:** unplanned return to theatre (variable time point) **Note:** • unplanned return to theatre: reasons for re-operation deep infection, segmental collapse, pain or non-union; types of re-operation were removal of fixation
Notes	**Funding/sponsor/declarations of interest:** funding not reported. Study authors declared royalties and payments for oral presentations from BBraun Aesculap. Study authors declare no conflicts of interest **Study dates:** July 2008 to September 2011 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

FAITH 2017

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Total number of randomised participants:** 1108 **Inclusion criteria:** ≥ 50 years of age (with no upper age limit); fracture of the femoral neck confirmed with either anteroposterior and lateral hip radiographs, CT, or MRI; operative treatment of displaced fractures within 4 days of presenting to the emergency room; operative treatment of undisplaced fractures within 7 days of presenting to the emergency room; ambulatory prior to fracture, though they may have used an aid such as a cane or a walker; anticipated medical optimisation for operative fixation of the hip; informed consent by participant or legal guardian; no other major trauma; low-energy fracture, in the judgement of the attending surgeon **Exclusion criteria:** participant not suitable for internal fixation; associated major injuries of the lower extremity; retained hardware around the affected hip; infection around the hip; disorders of known bone metabolism except osteoporosis; history of frank dementia that would interfere with assessment of the primary outcome; likely problems, in the judgment of the investigators, with maintaining follow-up **Setting:** multicentre; 81 clinical centres in: USA; Canada; Australia; the Netherlands; Norway; Germany; UK; India **Baseline characteristics** **Intervention group 1** (cancellous bone screws) • Age, mean (SD): 72 (± 12.3) years

FAITH 2017 *(Continued)*

- Gender, M/F: 210/325 (n = 535)
- Smoking history: never smoked: 276/532; current smoker: 100/532; former smoke 156/532
- Medication: none: 179/534; NSAIDS: 64/534; general cardiac: 167/534; opioid analgesics: 56/534; pulmonary drugs: 69/534; anti-hypertensives: 252/534; osteoporosis drugs: 73/534
- BMI: underweight (< 18.5 kg/m^2): 33/528; normal weight (18.5 to 24.9 kg/m^2): 300/528; overweight (25 to 29.9 kg/m^2): 148/528; obese (30 to 39.9 kg/m^2): 47/528
- Fracture classification: undisplaced: 369/537; displaced: 168/537

Intervention group 2 (sliding hip screw)

- Age, mean (SD): 72.2 (± 12) years
- Gender, M/F: 212/323 (n = 535)
- Smoking history: never smoked: 268/533; current smoker: 101/533; former smoke 164/533
- Medication: none: 170/535; NSAIDS: 86/535; general cardiac: 167/535; opioid analgesics: 43/535; pulmonary drugs: 58/535; anti-hypertensives: 244/535; osteoporosis drugs: 67/535
- BMI: underweight (BMI < 18.5 kg/m^2) 37/530; normal weight (18.5 to 24.9 kg/m^2) 276/530; overweight (25 to 29.9 kg/m^2) 159/530; obese (30 to 39.9 kg/m^2) 58/530
- Fracture classification: undisplaced: 360/542; displaced 182/542

Overall

- Age, mean (SD): 72.1 (± 12.2) years
- Gender, M/F: 422/648 (n = 1070)
- Smoking history: never smoked 544/1068; current smoker 201/1068; former smoker 320/1068
- Medication: none 349/1069; NSAIDS 150/1069; general cardiac 334/1069; opioid analgesics 99/1069; pulmonary drugs 127/1069; anti-hypertension drugs 496/1069; osteoporosis drugs 140/1069
- BMI: underweight (< 18.5 kg/m^2): 70/1058; normal weight (18.5 to 24.9 kg/m^2): 576/1058; overweight (25 to 29.9 kg/m^2): 307/1058; obese (30 to 39.9 kg/m^2): 105/1058
- Preoperative waiting time, mean (SD): 50.4 (± 69.5) hours (n = 496)
- Fracture classification: undisplaced: 729/1079; displaced: 350/1079
- Additional information: "balanced prognosis between intervention groups for fracture displacement, age, prefracture living status, prefracture function, American Society for Anesthesiologists class, and centre"

Note:

- study authors did not report any baseline data for: mobility assessment, place of residence, cognitive status, comorbidities

Interventions

General details: surgeon experience - completed 25 hip fracture fixation procedures during their career, and ≥ 5 fracture fixation procedures in the year before participation; in the sliding hip screw group, participants treated by: a surgeon = 292/533; a resident = 214/533; a fellow = 21/533; a registrar = 6/533; in the cancellous screw group, participants treated by: a surgeon = 295/532; a resident = 214/532; a fellow = 16/532; a registrar = 7/532. Treated with peri-operative antibiotics, thromboprophylaxis, consultation to optimise participant condition prior to surgery and weight-bearing regime; antibiotic prophylaxis, thromboprophylaxis, weight bearing, calcium 600 mg, appropriate nutritional assessment; not standardised physiotherapy and rehabilitation programs; surgical management was left at the discretion of the attending surgeon; anaesthetic management with general or regional anaesthesia

Intervention group 1

- Cancellous screws; type at the discretion of the attending surgeon; multiple threaded screws; minimum of 2 screws with diameter of 6.5 mm
- Randomised = 551; losses at end of follow-up = 325 (losses reported in flow-chart - 15 ineligible for inclusion; 118 did not complete follow-up owing to: death (73), could not be located (23), withdrew consent (19), other (3)); analysed for HRQoL = 238; analysed for mortality, unplanned return to theatre = 537

Intervention group 2

FAITH 2017 *(Continued)*

- Sliding hip screw, type at discretion of the attending surgeon, single large diameter (8 mm) partly threaded screw fixed to proximal femur with a side plate, no supplemental fixation
- Randomised = 557; losses at end of follow-up = 317 (losses reported in flow-chart - 14 ineligible for inclusion; 117 did not complete follow-up owing to: death (83), could not be located (23), withdrew consent (9), other (2)); analysed for HRQoL = 249; analysed for mortality and unplanned return to theatre = 542

Outcomes	**Outcomes measured/reported by study authors:** re-operation; mortality; fracture healing and shortening; fracture complications (AVN, non-union, implant failure, any infection, deep infection and superficial infection); HRQoL; adverse events; adverse events unrelated (renal; blood; neurological; pneumonia; decreased cognitive ability; MI; sepsis; urinary) **Outcomes relevant to the review:** unplanned return to theatre; mortality; HRQoL **Notes:** • study authors used two measurement tools to report HRQoL (EQ-5D and SF-12). In the review, we report data for EQ-5D as this was reported in another study in this comparison group which allowed for pooling of data • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty, removal of fixation and refixation
Notes	**Funding/sponsor/declarations of interest:** National Institutes of Health, Canadian Institutes of Health Research, Stichting NutsOhra, Netherlands Organisation for Health Research and Development, Physicians' Services Incorporated **Study dates:** March 2008 to March 2014

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Low risk	Quote: "Local research personnel at each site performed randomisation by minimisation using the centralised computer system. Surgeons and patients were not masked but the data analyst, while doing the analyses, remained masked to treatment groups."
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors describe the experience level of surgeons in each group, and we noted these were evenly balanced. However, it is unclear if each surgeon was equally experienced with both types of implants
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Study authors did not report whether participants were blinded to treatment allocation. However, we did not expect that lack of blinding would influence participants' assessment of their quality of life
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias):	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective

FAITH 2017 *(Continued)*

unplanned return to theatre		
Incomplete outcome data (attrition bias) All outcomes	Low risk	Overall losses in each group are balanced. Because the highest number of losses was caused by death, which might be expected in this age group, we were not concerned by these losses. We noted an inconsistent number of participants for which data is reported for each of the HRQoL measures which may indicate attrition bias for these measures
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Low risk	Study registered with a clinical trials register (NCT00761813; first received in Septemeber 2008), and protocol published 2014. Registration was completed shortly after the start of the study and the reported outcomes were consistent with those in the clinical trial registration documents

Fernandez 2022

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented

Participants	**Total number of randomised participants:** 1225
	
	Inclusion criteria: all patients, with and without capacity, presenting with a displaced intracapsular fracture of the hip suitable for HA
	
	Exclusion criteria: < 60 years old; managed non-operatively; treated with a THA
	
	Setting: multicentre; 14 hospitals; UK
	
	Baseline characteristics
	
	Intervention group 1 (cemented)
	
	• Age, mean (SD): 84.51 (± 7.57) years
	• Gender, M/F, n: 189/421
	• Smoking history, N/Y, n: 501/50
	• Co-morbidities, n:
	  ○ chronic renal failure: 52
	  ○ diabetes: 100
	• Mobility assessment, n:
	  ○ no aids: 197
	  ○ one aid: 161
	  ○ two aids: 118
	  ○ no mobility: 2
	  ○ indoor: 116
	• Place of residence, n:
	  ○ own home / sheltered housing: 425
	  ○ residential care: 67
	  ○ nursing care:, 58
	  ○ acute hospital:, 12
	  ○ rehabilitation unit: 1
	  ○ other: 3

Fernandez 2022 *(Continued)*

- Cognitive status, delirium 4AT, 0/ 1 to 3/ 4+, n: 230/110/162
- Cognitive status, AMTS, mean (SD), total: 46.53 (± 3.77), 570
- ASA status, I/II/III/IV/V, n: 7/93/379/84/3
- Preoperative waiting time, delay < 36 hours, n: 475
- Fracture classification, B1/B1 undisplaced/B3/B3 displaced, n: 2/8/63/526
- Additional information:
  - EQ-5D (index score), mean (SD), total: 0.58 (± 0.29), 485
  - EQ-5D (VAS), mean (SD), total: 61.63 (± 20.99), 466
  - alcohol, 0.7 / 8 to 14 / 15 to 21 / > 21 units, n: 494/28/10/13
  - nutritional risk assessment, risk of malnutrition/malnutrition, n: 83/24
  - pathological fracture, malignancy Y/N/unknown, n: 1/568/30

Intervention group 2 (uncemented)

- Age, mean (SD): 84.28 (± 7.41) years
- Gender, M/F, n: 204/411
- Smoking history, N/Y, n: 523/38
- Co-morbidities, n:
  - chronic kidney failure: 53
  - diabetes: 95
- Mobility assessment, n:
  - no aids: 207
  - one aid: 152
  - two aids: 126
  - no mobility: 4
  - indoor: 107
- Place of residence, n:
  - own home / sheltered housing: 400
  - residential care: 79
  - nursing care: 62
  - acute hospital: 16
  - rehabilitation unit: 8
  - other: 4
- Cognitive status, delirium 4AT, 0/ 1 to 3/ 4+, n: 210/115/178
- Cognitive status, AMTS, mean (SD), total: 47.27 (± 3.77), 579
- ASA class, I/II/III/IV/V, n: 4/94/369/97/3
- Preoperative waiting time, delay < 36 hours, n: 472
- Fracture classification, B1/B1 undisplaced/B3/B3 displaced, n: 1/9/66/527
- Additional information:
  - EQ-5D (index score), mean (SD), total: 0.55 (± 0.31), 499
  - EQ-5D (VAS), mean (SD), total: 62.51 (± 21.44), 484
  - alcohol, 0.7 / 8 to 14 / 15 to 21 / > 21 units, n: 515/22/9/9
  - Nutritional risk assessment, risk of malnutrition/malnutrition, n: 88/24
  - Pathological fracture, malignancy Y/N/unknown, n: 3/566/34

Note:

- study authors do not report medication type, BMI or comorbidities

Interventions	**General details:** appropriate preparation, positioning and surgical technique left to the discretion of the operating surgeon, according to their normal clinical practice; range of surgeon experience including consultant, specialty and associate specialist; speciality trainee surgeons and staff grade **Intervention group 1** • HA cemented; including 171 bipolar and 407 unipolar; 60% general anaesthesia; 77% uncollared

Fernandez 2022 *(Continued)*

	• Randomised = 610 **Intervention group 2** • HA uncemented; modern; including 187 bipolar and 411 unipolar; 593 HA coated; 62% general anaesthesia; 25% uncollared • Randomised = 615 **Note:** • study authors provided data on treatment received as well as treatment allocated • we used ITT analysis in the review. Per protocol data were also provided by study authors
Outcomes	**Outcomes measured/reported by study authors:** mortality; HRQoL; discharge destination; mobility; adverse events: dislocation; DVT; cerebrovascular injury; wound infection; venous thromboembolism; pneumonia; UTI; MI; blood transfusion; acute kidney injury; per-prosthetic fracture; neurological injury; vascular injury; tendon injury; erythema; dehiscence; chest infection; failure of fixation; unplanned return to theatre **Outcomes relevant to the review:** mortality (4 and 12 months); HRQoL (EQ-5D, 4 and 12 months); unplanned return to theatre
Notes	**Funding/sponsor/declarations of interest:** National Institute for Health Research, Research for Patient Benefit **Study dates:** March 2017 to December 2019 **Note:** • we did not complete risk of bias assessment because we did not include data from this study in the network meta-analysis

Figved 2009

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 230 fractures (223 patients; 7 patients with both hips were included); 3 protocol violations results in 220 patients **Inclusion criteria:** ≥ 70 years of age; displaced intracapsular fracture of femoral neck **Exclusion criteria:** unfit for arthroplasty according to the anaesthesiologist on call; osteoarthritis; fracture caused by malignant disease; ongoing infectious disease; unable to walk before the fracture **Setting:** 2 centres; hospitals; Norway **Intervention group 1** (cemented) • Age, mean (SD): 83.4 (± 5.7) years • Gender, M/F, n: 25/87 • Mobility assessment, walk without any aid, n: 56 • Place of residence, living in own home, n: 77 • Cognitive status, previously recognised cognitive failure, n: 26 • ASA status, I or II, n: 47 • Preoperative waiting time, admission to surgery, mean (SD): 21.9 (± 18.3) hours

Figved 2009 *(Continued)*

- Fracture classification, n: 100% displaced
- HHS, mean (SD): 82.4 (± 16.3)

Intervention group 2 (uncemented)

- Age, mean (SD): 83.0 (± 6.3) years
- Gender, M/Fn: 28/80
- Mobility assessment, walk without any aid, n: 59
- Place of residence, living in own home, n: 76
- Cognitive status, previously recognised cognitive failure, n: 28
- ASA status, I or II, n: 47
- Preoperative waiting time, admission to surgery, mean (SD): 19.1 (± 14.4) hours
- Fracture classification, n: 100% displaced
- HHS, mean (SD): 84.6 (± 15.1)

Note:

- study authors did not report any baseline data for: smoking history, medication, BMI

Interventions	**General details:** 36 surgeons; all patients received a 28 mm cobalt-chromium head and the same bipolar head (Mobile Cup; DePuy); posterior approach with the patient in a lateral decubitus position; spinal anaesthesia; 2 g preoperative intravenous cefalotin and an additional three doses the first 16 hours after the operation; 5000 IU low-molecular-weight heparin subcutaneously daily for at least 7 days; early mobilisation was encouraged in all patients with weight bearing as tolerated. **Intervention group 1** • HA cemented femoral stem, Spectron (Smith & Nephew, Inc, Memphis, USA) with bipolar head; third-generation cementing technique • Randomised = 112 (after protocol violations); analysed for mortality = 108; analysed for EQ-5D at 12 months = 61; analysed for unplanned return to theatre = 112 **Intervention group 2** • HA uncemented femoral stem, Corail (DePuy International Ltd, Leeds, UK) with bipolar head • Randomised = 108 (after protocol violations); analysed for mortality = 105; analysed for EQ-5D at 12 months = 60; analysed for unplanned return to theatre = 108
Outcomes	**Outcomes measured/reported by study authors:** duration of surgery; blood loss; blood transfusions; length of stay in hospital; mortality (at 7, 30, 90 days; and at 12, 24 months, 5 years); HHS, Barthel Index and EQ-5D (available at 3 months, 12 months, 5 years); living in own home (discharge, 3 and 12 months); no pain medication (discharge, 3, 12 months, 5 years); walking independently (at discharge, 3 and 12 months); pneumonia; dislocation; DVT; superficial (wound) infection; pulmonary embolism; fracture of the contralateral hip; deep infection; intraoperative periprosthetic fracture; postoperative periprosthetic fracture; postoperative MI not leading to death; perioperative death; intraoperative severe decrease in blood pressure during preparation of the femoral canal; peri-operative MI leading to death; intraoperative cardiac arrest **Outcomes relevant to the review:** mortality (3, 12 months, 5 years); EQ-5D (at 3 months, 12 months, 5 years); unplanned return to theatre (12 months) **Notes:** • we have used 5-year data from a linked publication (Lanslet 2014) • unplanned return to theatre: reasons for re-operation were infection and periprosthetic fracture; types of re-operation were not reported
Notes	**Funding/sponsor/declarations of interest:** funding from Eastern Norway Regional Health Authority (nonprofit, governmental). At least 1 study author received funding from Smith & Nephew, Inc, and from OrtoMedic AS

Figved 2009 *(Continued)*

Study dates: September 2004 to August 2006

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was performed separately for the two hospitals using a computer random number generator with permuted blocks of five"
Allocation concealment (selection bias)	Low risk	Quote: "Allocation was done by the surgeon on call using sealed, numbered, opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that the interventions were performed according to usual hospital procedures but we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Study authors did not report whether participants were blinded to treatment allocation. However, we did not expect that lack of blinding would influence participants' assessment of their quality of life
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death or otherwise clearly reported
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Retrospectively registered with a clinical trials register (NCT00491673; first received June 2007). Study commenced in 2004 and it was not feasible to effectively assess risk of selective reporting bias with these documents

Figved 2018

Study characteristics

Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar
Participants	**Total number of randomised participants:** 28 **Inclusion criteria:** ≥ 70 years of age; displaced intracapsular fracture femoral neck; living independently; walking without aids

Figved 2018 *(Continued)*

Exclusion criteria: cognitive impairment; osteoarthritis; a fracture caused by malignant disease; ongoing infectious disease

Setting: single centre; hospital; Norway

Intervention group 1 (bipolar)

- Age, median (range): 80 (70 to 89) years
- Gender, M/F, n: 3/11
- Preoperative HHS, mean (SD): 96 (± 4)
- Preoperative EQ-5D, mean (SD): 0.91 (± 0.11)
- Fracture classification, n: all displaced

Intervention group 2 (unipolar)

- Age, median (range): 81 (70 to 90) years
- Gender, M/F, n: 3/11
- Preoperative HHS, mean (SD): 94 (± 6)
- Preoperative EQ-5D, mean (SD): 0.90 (± 0.12)
- Fracture classification, n: all displaced

Note:

- study authors did not report: smoking history, BMI, medication, mobility assessment, ASA status, preoperative waiting time

Interventions	**General details:** uncemented pressfit hydroxyapatite-coated femoral stem (Corail, DePuy Orthopaedics Inc, Warzaw, IN, USA); posterior approach with the patient in the lateral decubitus position; spinal anaesthesia; 6 experienced surgeons; preoperative IV cefalotin 2 g and a further 3 doses in the first 12 hours after the operation; 5000 IU low-molecular-weight heparin subcutaneously daily for at least 10 days; early mobilisation was encouraged, with weight bearing as tolerated **Intervention group 1** • HA bipolar; 28 mm cobalt chromium head and a bipolar head (SelfCentering™ Bipolar, DePuy Orthopaedics Inc, Warzaw, USA), uncemented • Randomised = 14; 4 lost to follow-up at 1 year (1 conversion to THA because of infection; 2 dead; 1 withdrawn from trial); analysed for mortality = 14; analysed for HRQoL = 12 **Intervention group 2** • HA unipolar; modular unipolar head (Modular Cathcart Unipolar, DePuy Orthopaedics Inc, Warzaw, USA), uncemented • Randomised = 14; 5 lost to follow-up at 1 year (1 re-operated due to dislocation; 1 dead); analysed for mortality = 14; analysed for HRQoL = 12
Outcomes	**Outcomes measured/reported by study authors:** migration of femoral head, cartilage wear; HHS, EQ-5D index and VAS (at 3, 12, and 24 months); mortality (data available at 12 months and 24 months) **Outcomes relevant to the review:** HRQoL (EQ-5D index; at 12 months); mortality (at 12 months) **Notes:** • we did not use the mean and SD for 12 month data provided by study authors (via email communication). The direction of effect in these mean data was not consistent with the median values in the published report and we expected that this difference was related to the small population size in this study.
Notes	**Funding/sponsor/declarations of interest:** research grant from Smith & Nephew, Norway. Study authors declare no other conflicts of interest

Figved 2018 *(Continued)*

Study dates: Sept 2004 to August 2006

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was performed using a computer random number generator"
Allocation concealment (selection bias)	Low risk	Quote: "Allocation was done by the surgeon on call using sealed envelopes" Comment: study authors do not report if envelopes are opaque and sequentially numbered. However, because the same study authors report using opaque, numbered envelopes in Figved 2009, we have assumed this to also be the case in this study
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that the interventions were all performed by experienced surgeons but we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Study authors did not report whether participants were blinded to treatment allocation. However, we did not expect that lack of blinding would influence participants' assessment of their quality of life
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Reasons for attrition are clearly reported in CONSORT diagram; losses are few and are balanced between groups
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Retrospectively registered with clinicaltrials.gov (NCT00746876, first received September 2008). It is not feasible to use these documents to effectively assess risk of selective reporting bias

Frandsen 1981

Study characteristics

Methods	Quasi-RCT; parallel design **Review comparison group:** smooth pin versus fixed angle plate
Participants	**Total number of randomised participants:** 383 **Inclusion criteria:** displaced medial fractures of the femoral neck

Frandsen 1981 *(Continued)*

Exclusion criteria: pathological fractures; death before surgery was performed; old fractures in which surgery was not indicated; refusal to participate in surgery (on religious grounds); follow-up not possible (because not a permanent resident in the country)

Setting: single centre; university hospital; Denmark

Baseline characteristics

Intervention group 1 (Smith-Petersen Thornton nail)

- Age, median (range): 78 (28 to 96) years
- Age, < 49 years, n: 2
- Age, 50 to 59 years, n: 14
- Age, 60 to 69 years, n: 31
- Age, 70 to 79 years, n: 67
- Age, 80 to 89 years, n: 68
- Age, > 90 year, n: 14
- Fracture classification, undisplaced/displaced: all displaced

Intervention group 2 (sliding nail plate)

- Age, median (range): 77 (22 to 95) years
- Age, < 49 years, n: 4
- Age, 50 to 59 years, n: 13
- Age, 60 to 69 years, n: 33
- Age, 70 to 79 years, n: 66
- Age, 80 to 89 years, n: 55
- Age, > 90 year, n: 16
- Fracture classification, undisplaced/displaced: all displaced

Overall

- Gender, M/F: 86/297

Notes:

- study authors did not report the following baseline characteristics: gender (by group), smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, preoperative waiting time

Interventions

General details: traction through the tibia applied on admission, and final adjustment of the fracture made under general anaesthesia on the fracture table with fluoroscopy. Surgery performed at the earliest opportunity (but not as an emergency). Early mobilisation encouraged (out of bed, sitting in a chair on POD1; allowed to walk with elbow crutches on POD 2 and POD 3). Weight bearing allowed, except for younger participants. Surgery conducted by same doctors for both types of intervention

Intervention group 1

- Smith-Petersen osteosynthesis using a Thornton nail
- Randomised = 196; lost to follow-up = 83 (owing to death, or refusal to participate); analysed = 196
- Follow-up: final follow-up median (range) 25 (24 to 65) months

Intervention group 2

- Sliding-nail plate
- Randomised = 187; lost to follow-up = 69 (owing to death, or refusal to participate); analysed = 187
- Follow-up: final follow-up median (range) 32 (24 to 62) months

Notes:

Frandsen 1981 *(Continued)*

	• study authors did not report the following intervention details: number of clinicians (and their skill or experience), use of prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes reported/measured by study authors:** mortality, union, failure, AVN, deep infection, phlebothrombosis, pulmonary embolism, cardiac disease, pulmonary disease, decubital ulcer **Outcomes relevant to the review:** mortality (one month)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** March 1972 to August 1977 **Note:** • we have used data from the final publication of this study, rather than an earlier interim publication (Frandsen 1979)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Allocated to intervention using alternate days, according to day of emergency admission
Allocation concealment (selection bias)	High risk	Owing to use of alternate days to allocate participants, we expected that allocation concealment was not possible
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were experienced in both techniques
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Twenty-one participants were lost to follow-up (owing to refusal to participate); the remaining losses were due to deaths. Losses because of refusal to participate were < 10% overall, sufficiently balanced between groups, and we did not expect these losses to influence outcome data
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Frihagen 2007

Study characteristics

Methods	RCT; parallel design

Frihagen 2007 *(Continued)*

Review comparison group: internal fixation (IF) versus HA

Participants	**Total number of randomised participants:** 222
	
	Inclusion criteria: ≥ 60 years of age; previously ambulant; angular displacement. People who could not give consent because of temporary or permanent cognitive impairment were included if it was considered to be in their best interest after consultation with their family
	
	Exclusion criteria: unfit for arthroplasty; hip pathology (such as arthritis); pathological fracture; delay of > 96 hours from injury to treatment; or living outside the hospital's designated area
	
	Setting: single centre; hospital; Norway
	
	Baseline characteristics
	
	Intervention group 1 (IF)
	
	• Age, mean (SD): 83.2 (± 7.65) years
	• Gender, M/F: 25/87
	• Comorbidities, symptomatic medical disease , n: 52
	• Mobility assessment, walk without any aid: 67
	• Place of residence, living in own home, n: 80
	• Cognitive status, previously recognised cognitive failure, n: 40
	• ASA status, group I/II, n: 59
	• Preoperative waiting time, injury to admission, mean (SD), n: 8 (± 14.3) hours, 94
	• Additional information:
	  ◦ HHS prior to fracture, mean (SD), n: 84.3 (± 14.72), 109
	  ◦ Concurrent condition or impairment likely to affect rehabilitation, n: 74
	
	Intervention group 2 (HA)
	
	• Age, mean (SD): 82.5 (± 7.32) years
	• Gender, M/F: 32/78
	• Comorbidities, symptomatic medical disease , n: 64
	• Mobility assessment, walk without any aid: 60, n=107
	• Place of residence, living in own home, n: 83
	• Cognitive status, previously recognised cognitive failure, n: 29
	• ASA status, group I/II, n: 52
	• Preoperative waiting time, injury to admission, mean (SD), n: 5.5 (± 15.2) hours, 83
	• Additional information:
	  ◦ HHS prior to fracture, mean (SD), n: 83.6 (± 13.59), 100
	  ◦ Concurrent condition or impairment likely to affect rehabilitation, n: 73
	
	Note:
	
	• Study authors did not report the following baseline characteristics: smoking history, medication and BMI

Interventions	**General details:** scheduled follow-up visits at 4, 12, and 24 months; 28 surgeons on call carried out all the operations; spinal anaesthesia; 5000 IU low-molecular-weight heparin subcutaneously daily until they could move relatively well; early mobilisation was encouraged, with weight bearing as tolerated **Intervention group 1:** • IF; 2 parallel cannulated screws (Olmed, DePuy/Johnson & Johnson, Sweden); closed reduction • Randomised = 112; loss to follow-up for HRQoL 79 reported at 4 months, 70 at 12 months and 31 at 6 years **Intervention group 2:**

Frihagen 2007 *(Continued)*

- HA; Charnley-Hastings bipolar cemented HA (DePuy/Johnson & Johnson, UK); direct lateral approach; patient in a lateral decubitus position with a third-generation cementing technique; preoperative intravenous cefalotin 2 g and a further three doses the first 24 hours after the operation
- Randomised = 110; loss to follow-up for HRQoL 70 reported at 4 months, 62 at 12 months and 37 at 6 years

Note:

- Both interventions were standard operations in the department before the study
- One patient was included with both hips, 34 days apart, with one hip in either group

Outcomes	**Outcomes measured/reported by study authors:** mortality (data available at: 1, 3, 4, 12, 24 months and 6 years); HHS (4, 12 and 24 months); HRQoL (EQ-5D, at 4, 12 and 24 months); ADL (Barthel at 4, 12 and 24 months); blood transfusion; complications: wound dehiscence > 1 week, painful protruding screws, painful heterotopic ossification, deep venous thrombosis, pulmonary embolism, pressure sore, ipsilateral above-knee amputation, radiographic loosening of hemiarthroplasty, dislocation of hemiarthroplasty, deep infection, mechanical failure of internal fixation/non-union; re-operation (24 months) **Outcomes relevant to the review:** mortality (4, 12 months and 6 years); HRQoL (EQ-5D, at 4, 12 months and 6 years); unplanned return to theatre, reported as number of hips re-operated (at 24 months and 6 years)
Notes	**Funding/sponsorship/declarations of interest:** Norwegian Foundation for Health and Rehabilitation through the Norwegian Osteoporosis Society and the Norwegian Research Council, Nycomed, Smith & Nephew, and OrtoMedic. Some authors have received lecture and/or consulting fees from manufacturers of orthopaedic implants **Study dates:** September 2002 to March 2004

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "We randomly placed 115 pieces of paper with the word “hemi” and 115 with the word “screws” in opaque envelopes"
Allocation concealment (selection bias)	Low risk	Opaque envelopes were sealed and numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to interventions. We did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	On-call surgeons. It is not clear if surgeons were equally experienced with both techniques
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Study authors did not report whether participants were blinded to treatment allocation. However, we did not expect that lack of blinding would influence participants' assessment of their quality of life
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not believe that lack of blinding would influence data for this outcome
Blinding of outcome assessment (detection bias):	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective

Frihagen 2007 *(Continued)*

unplanned return to theatre		
Incomplete outcome data (attrition bias) All outcomes	High risk	We noted loss of data for HRQoL at each time point which is not clearly explained
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study is retrospectively registered with a clinical trials register (NCT00464230; first received April 2007). It is not feasible to effectively assess risk of selective reporting bias using these documents

Griffin 2014

Study characteristics	
Methods	RCT; single centre; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Total number of randomised participants:** 174 **Inclusion criteria:** ≥ 65 years of age; displaced or undisplaced intracapsular hip fracture, including those with cognitive impairment **Exclusion criteria:** if managed non-operatively, presenting late, other serious injuries, existing local disease **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1** (cannulated screws) • Age, mean (SD): 83 (± 7.7) years • Gender, M/F: 31/92 • Smoking history: current smoker: 12 • Medication: currently prescribed antiplatelets; 37; NSAIDs: 5; previously or currently prescribed systemic steroid: 8 • Comorbidities, type: previously diagnosed CRF: 6; diabetes mellitus: 10; osteoporosis: 25 • Cognitive status: demented (AMT < 8): 38 • Preoperative waiting time, mean (SD): 31 (± 30) hours • Fracture classification, minimally displaced: 25 • Additional information: EQ-5D: mean 0.67 (± 0.32) **Intervention group 2** (Targon Femoral Neck plate) • Age, mean (SD): 83 (± 7.6) years • Gender, M/F: 14/37 • Smoking history: 3 current smokers • Medication: currently prescribed antiplatelets: 9; NSAID: 3; previously or currently prescribed systemic steroid: 4 • Comorbidities, type: previously diagnosed CRF: 4; diabetes mellitus: 8; osteoporosis: 16 • Cognitive status: demented (AMT < 8): 18 • Preoperative waiting time, mean (SD): 28 (± 21) hours38 • Fracture classification: minimally displaced 10/51

Griffin 2014 *(Continued)*

	• Additional information: EQ-5D: mean 0.69 (± 0.26) **Note:** • study authors did not report baseline data for: BMI, mobility assessment, place of residence
Interventions	**General details:** 24 specialist trainees under supervision of consultant trauma surgeons; closed reduction of the fracture (note: if the fracture was displaced, allocation only performed after successful closed reduction); perioperative antibiotics; early active mobilisation and immediate full weight bearing; standardised physiotherapy rehabilitation regime **Intervention group 1** • Cannulated screws, used at discretion of attending surgeon, using standardised clinical management • Randomised = 123, lost to follow-up 24, analysed = 99 **Intervention group 2** • Targon Femoral Neck hip screw - fixation was achieved in accordance with the manufacturer's recommended technique. Surgeons received a standardised training package • Randomised = 51, lost to follow-up 10, analysed = 41
Outcomes	**Outcomes measured/reported by study authors:** re-operation for failure of fixation (1 year); non-union (radiological; 1 year); AVN (radiological; 1 year); HRQoL (EQ-5D: 6, 12, and 52 weeks); length of hospital stay; mortality; adverse events (wound infection, pulmonary embolus, pneumonia, UTI, blood transfusion, CVA, acute coronary syndrome, MI, DVT) **Outcomes relevant to the review:** unplanned return to theatre (failure of fixation; 1 year); HRQoL; mortality **Note:** • we did not include data for HRQoL which were not reported in the study report. We contacted the study authors, but these data were no longer available • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were not reported
Notes	**Funding/sponsor/declarations of interest:** the Bupa Foundation supported salaries and consumables, B. Braun UK supported the Targon system but had no involvement in data collection or analysis **Study dates:** September 2009 and October 2011

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Treatment allocation was determined using a computer-generated, randomised number sequence administrated by an independent Clinical Trials Unit via a secure online programme
Allocation concealment (selection bias)	Low risk	Allocation managed centrally and code only broken at the end of the trial
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Low risk	Operations were performed under the supervision of an experienced consultant surgeon, and surgeons were all given training in use of the implants

Griffin 2014 *(Continued)*

Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Loss to follow-up was clearly reported and equal between groups. Most losses could be explained by death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Low risk	Study is registered on a clinical trials register (ISRCTN49197425, first received April 2010), and protocol submitted on May 2010. Registration was completed shortly after the start of the study and the reported outcomes were mostly consistent with those in the clinical trial registration documents

Griffin 2016

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA with single articulation vs THA with dual-mobility (DM)

Participants	**Total number of randomised participants:** 21
	
	Inclusion criteria: aged > 60 years; displaced intracapsular fracture
	
	Exclusion criteria: chronic cognitive impairment; in the opinion of the consultant trauma surgeon the patient would not benefit from a THA; treated non-operatively
	
	Setting: single centre; hospital; UK
	
	Intervention group 1 (THA)
	
	• Smoking history, n: 90%
	• Comorbidities, type, %:
	  ○ diabetes: 0
	  ○ chronic renal failure: 0
	  ○ 7 units alcohol/week: 0
	• Fracture classification, n: 100% displaced
	• Baseline participant-recorded outcomes:
	  ○ OHS, mean (SD): 1.8 (± 2.6)
	  ○ EQ-5D-3L, mean (SD): 0.82 (± 0.29)
	  ○ ICECAP-O, mean (SD): 0.81 (± 0.26)
	
	Intervention group 2 (THA-DM)
	
	• Smoking history, n: 80%
	• Comorbidities, type, %:
	  ○ diabetes: 2
	  ○ chronic renal failure: 1
	  ○ 7 units alcohol/week: 1

Griffin 2016 *(Continued)*

- Fracture classification, n: 100% displaced
- Baseline participant-recorded outcomes:
  - OHS, mean (SD): 9.0 (± 11.8)
  - EQ-5D-3L, mean (SD): 0.73 (± 0.30)
  - ICECAP-O, mean (SD): 0.66 (±0.34)

Note:

- study authors did not report: age; gender; medication; BMI; mobility; place of residence; cognitive status/dementia; ASA status; preoperative waiting time

Interventions	**General details:** antibiotic and venous thromboembolic prophylaxis, procedure undertaken in lateral-position; routine follow-up at 1, 4 and 12 months **Intervention group 1** • THA standard bearing; surgeon selected the prosthesis • Randomised = 10; losses = 1 (reason for loss not reported); analysed for mortality and unplanned return to theatre = 10; analysed for EQ-5D at 4 months = 7; analysed for EQ-5D at 12 months = 9 **Intervention group 2** • THA dual-mobility cup; surgeon selected the prosthesis with a dual-mobility acetabular component; uncemented Novae DM acetabular component (SERF Dedienne Santé, Lyon, France) • Randomised = 11; reported losses = 2 (1 withdrew, 1 died; other losses are unexplained); analysed for EQ-5D at 4 months = 9; analysed for all outcomes at 12 months = 10
Outcomes	**Outcomes measured/reported by study authors:** dislocation; OHS, EQ-5D, ICECAP-O - available at 1 month, 4 months, and 12 months; mortality (12 months); re-operation **Outcomes relevant to the review:** HRQoL (EQ-5D; 4 months and 12 months); mortality (12 months); unplanned return to theatre **Notes:** • we contacted study authors, who provided data for EQ-5D at 4 months and 12 months
Notes	**Funding/sponsor/declarations of interest:** funded by National Institute for Health Research Portfolio **Study dates:** June 2013 to May 2014

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were randomly allocated to treatment groups
Allocation concealment (selection bias)	Low risk	Randomisation was administered via an online service administered by an independent Clinical Trials Unit
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Patients and research associates, but not the operating surgeon, were blinded to the allocation of treatment. We did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study

Griffin 2016 *(Continued)*

Blinding of outcome assessment (detection bias): HRQoL	Low risk	Study authors did not report whether participants were blinded to treatment allocation. However, we did not expect that lack of blinding would influence participants' assessment of their quality of life
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Loss to follow-up is clearly reported
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Low risk	Prospectively registered with a clinical trials register (ISRCTN90544391, first received April 2013). Outcomes in the published report are consistent with those in clinical trial registration and protocol

Harper 1994a

Study characteristics	
Methods	RCT; single centre; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Total number of randomised participants:** 209 **Inclusion criteria:** ≤ 80 years; mental test score > 3, undisplaced fractures **Exclusion criteria:** where an adequate reduction could not be achieved **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1** (cannulated screws) • Age, mean (SD; range): 71.9 (± 10.2; 42 to 91) years • Gender, M/F: 25/82 • Cognitive status, mental test score, mean (SD): 10.59 (± 2.62) • Fracture classification, undisplaced/displaced: 16/91 **Intervention group 2** (Ambi hip screw) • Age, mean (SD; range): 72.2 (± 11.6; 25 to 93) years • Gender, M/F: 29/73 • Cognitive status, mental test score, mean (SD): 10.49 (± 2.57) • Fracture classification, undisplaced/displaced: 20/82
Interventions	**General details:** a single surgeon; weight bearing allowed after 24 hours; clinical follow-up at 6 weeks, 3 months, 6, 12 and 18 months **Intervention group 1** • Cannulated screws (Richards Medical), 3 parallel screws • Randomised = 107; no losses; analysed = 107

Harper 1994a *(Continued)*

	Intervention group 2 • Ambi hip screw (Richards Medical); lag screw with side plate • Randomised = 102; no losses; analysed = 102 **Note:** 214 were eligible, but 5 were excluded, 1 declined to participate, 2 inadequate reduction, and 2 could not be positioned adequately to use cannulated screws and were treated with an alternative implant
Outcomes	**Outcomes measured/reported by study authors:** mortality (available during hospital stay, at 3 and 12 months); re-operation due to failure (defined as requiring a revision to the implant, painful non-union or AVN) **Outcomes relevant to the review:** mortality (at 3 months and 12 months); unplanned return to theatre **Note:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsor/declarations of interest:** Richards Medical Ltd supplied equipment at reduced cost, and financial support from Glaxo Laboratories Ltd for administrative costs **Study dates:** January 1989 to March 1990

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomised but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	A single surgeon performed all operations. However, it is uncertain whether the surgeon was equally experienced with both implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few participants did not have treatment (and reasons were provided). No losses after treatment, and all participants were followed up
Other bias	Low risk	We identified no other sources of bias

Harper 1994a *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Harper 1994b

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 137 **Inclusion criteria:** • > 80 years of age; mental test score above 3 • < 80 years of age; mental test score of 3 or below **Exclusion criteria:** none reported **Setting:** single centre; hospital; UK **Intervention group 1** (cemented) • Age, mean (SD, range): 84.2 (± 6.0, 60-100) • Gender, M/F, n: 17/54 • Smoking history, n: 90% • Cognitive status/dementia, mean mental test score (SD): 6.66 (± 4.12) • Fracture classification, n: 100% displaced **Intervention group 2** (uncemented) • Age, mean (SD, range): 82.07 (± 10.8, 64-98) • Gender, M/F, n: 18/48 • Cognitive status/dementia, mean mental test score (SD): 6.83 (± 4.15) • Fracture classification, n: 100% displaced **Note:** • study authors did not report: medication; BMI; mobility; place of residence; comorbidities; ASA status; preoperative waiting time
Interventions	**General details:** a direct lateral approach was used; patient supine; femoral head diameter was measured and a prosthesis of appropriate size used; Thompson prostheses; weight bearing after 48 hours **Intervention group 1** • HA cemented; Thompson (unipolar) • Randomised = 71; 1 died during surgery, 3 died during hospital stay; analysed for length of hospital stay = 67; analysed = 71 **Intervention group 2** • HA uncemented; Thompson (unipolar); the femoral cavity was only partially reamed; polymethyl methacrylate cement was inserted by a finger packing technique • Randomised = 66; 2 died during hospital stay; analysed for length of hospital stay = 64; analysed = 66

Harper 1994b *(Continued)*

Outcomes	**Outcomes measured/reported by study authors:** dislocation; mortality; superficial and deep infection; length of stay in hospital; pain **Outcomes relevant to the review:** mortality (3 and 12 months)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** January 1989 to January 1990

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation procedure not clearly described
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

HEALTH 2019

Study characteristics

Methods	RCT; parallel design **Review comparison group:** THA versus HA
Participants	**Total number of randomised participants:** 1495 **Inclusion criteria:** adult men or women ≥ 50 years of age (with no upper age limit); fracture of the femoral neck confirmed with anteroposterior and lateral radiographs, or CT or MRI; displaced fracture that is not, in the judgment of the attending surgeon, optimally managed by reduction and internal fixation; operative treatment within 72 hours of the patient being medically cleared for surgery; patient was ambulatory prior to fracture, though they may have used an aid such as a cane or a walker;

HEALTH 2019 *(Continued)*

anticipated medical optimisation for arthroplasty of the hip; provision of informed consent by patient or proxy; low-energy fracture (defined as a fall from standing height); no other major trauma (defined as an ISS < 17); assurance that surgeons with expertise in both THA and HA are available to perform surgery

Exclusion criteria: not suitable for HA (e.g. inflammatory arthritis, rheumatoid arthritis, pathological fracture (secondary to cancer) or severe osteoarthritis of the hip); associated major injuries of the lower extremity (e.g. ipsilateral or contralateral fractures of the foot, ankle, tibia, fibula, knee or femur; dislocations of the ankle, knee or hip; or femoral head defects or fracture); retained hardware around the affected hip that will interfere with arthroplasty; infection around the hip (soft tissue or bone); disorder of bone metabolism other than osteoporosis (e.g. Paget's disease, renal osteodystrophy, osteomalacia); previous history of frank dementia that would interfere with assessment of the primary outcome (i.e. secondary procedures at 2 years); likely problems, in the judgement of the investigators, with maintaining follow-up (e.g. participants with no fixed address, report a plan to move out of town, alcohol abuse issues or intellectually challenged participants without adequate family support); fracture occurred as a result of an act of violence

Setting: multicentre; hospital; Canada, USA, Spain, UK, the Netherlands, Norway, Finland, New Zealand, South Africa

Intervention group 1 (THA; data missing for small number of participants for some outcomes)

- Age, mean (SD): 79.1 (± 8.3) years
- Gender, M/F, n: 208/510
- Weight, n/total:
  - underweight, < 18.5 kg/m^2: 35/697
  - normal weight, 18.5 to 24.9 kg/m^2: 357/697
  - overweight, 25 to 29.9 kg/m^2: 217/697
  - obese, 30 to 39.9 kg/m^2: 77/697
  - morbidly obese, ≥ 40 kg/m^2: 11/697
- Comorbidities, type, n/total:
  - osteopenia: 28/715
  - osteoporosis: 114/715
  - lung disease: 127/715
  - diabetes: 135/715
  - ulcers or stomach disease: 49/715
  - kidney disease: 71/715
  - anaemia or other blood disease: 48/715
  - depression: 70/715
  - cancer: 65/715
  - osteoarthritis, degenerative arthritis: 111/715
  - back pain: 64/715
  - rheumatoid arthritis: 13/715
  - heart disease: 247/715
  - high blood pressure: 434/715
- Mobility assessment/use of walking aides, n/total:
  - uses assistive device for ambulation: 187/718
  - able to ambulate without assistive device: 531/718
- Fracture classification, Garden's III/IV, n/total: 311/404
- ASA status, I/II/III/IV/V: 22/280/305/50/0
- Place of residence, n/ total:
  - institutionalised: 30/718
  - not institutionalised: 688/718
- Race or ethnic group, n/total: Native or Aboriginal: 2/716; South Asian: 3/716; East Asian: 7/716; Hispanic or Latino: 7/716; White: 683/716: Black: 12/716: Middle Eastern: 2/716

HEALTH 2019 *(Continued)*

Intervention group 2 (HA; data missing for small number of participants for some outcomes)

- Age, mean (SD): 78.6 (± 8.6)
- Gender, M/F, n: 223/499
- Weight, n/total:
  - underweight, < 18.5 kg/m^2: 38/705
  - normal weight, 18.5 to 24.9 kg/m^2: 336/705
  - overweight, 25 to 29.9 kg/m^2: 243/705
  - obese, 30 to 39.9 kg/m^2: 83/705
  - morbidly obese, ≥ 40 kg/m^2: 5/705
- Comorbidities, type, n/total:
  - osteopenia: 30/722
  - osteoporosis: 110/722
  - lung disease: 122/722
  - diabetes: 145/722
  - ulcers or stomach disease: 67/722
  - kidney disease: 67/722
  - anaemia or other blood disease: 55/722
  - depression: 84/722
  - cancer: 80/722
  - osteoarthritis, degenerative arthritis: 91/722
  - back pain: 71/722
  - rheumatoid arthritis: 21/722
  - heart disease: 249/722
  - high blood pressure: 443/722
- Mobility assessment/use of walking aides, n/total:
  - uses assistive device for ambulation: 182/723
  - able to ambulate without assistive device: 541/723
- Fracture classification, Garden's III/IV, n: 320/402
- ASA status, I/II/III/IV/V: 20/275/326/51/0
- Place of residence, n/total:
  - institutionalised: 27/723
  - not institutionalised: 696/723
- Race or ethnic group, n/total: Native or Aboriginal: 1/721; South Asian: 6/721; East Asian: 7/721; Hispanic or Latino: 6/721; White: 684/721; Black: 15/721; Middle Eastern: 2/721

Note:

- study authors did not report baseline characteristics for: smoking history, medication, cognitive status, preoperative waiting time

Interventions

General details: each surgical team used their preferred implant, surgical technique, type of anaesthesia, postoperative mobility/weight-bearing regimen approach. All are reported in study appendices along with clinicians' skills and experience. Preoperative antibiotic prophylaxis; thromboprophylaxis; medical consultation to optimise condition prior to surgery; postoperative antibiotic prophylaxis for 24 hours; thromboprophylaxis; weight bearing as tolerated; 600 mg calcium by mouth daily; 1000 IU vitamin D per day

Intervention group 1

- THA; choice of implant at surgeon's discretion, including the use of cemented components, the implant manufacturer or femoral head size
- Excluded: minimally invasive or hinged prostheses or capture cups
- Randomised = 749

Intervention group 2

HEALTH 2019 *(Continued)*

- HA; choice of implant at surgeon's discretion, including modular unipolar versus bipolar, and cement or uncemented
- Excluded: non-modular and non-canal filling unipolar implants, such as Moore's and Thompson's prostheses
- Randomised = 746

Outcomes	**Outcomes measured/reported by study authors:** unplanned secondary hip procedure within 24 months; death; serious adverse events; hip-related complications; HRQoL (SF-12 and EQ-5D); function (WOMAC and TUG scores) **Outcomes relevant to the review:** unplanned return to theatre; mortality (at 2 years); HRQoL (EQ-5D; at 24 months) **Notes:** • mean and SD provided by authors for HRQoL (via email communication) • study authors reported HRQoL using two measurement tools (SF-12 and EQ-5D). We used data using EQ-5D because this was measured by more of the studies in this comparison group. • unplanned return to theatre: reasons for re-operation dislocation, loosening, implant failure, periprosthetic fracture, infection, heterotopic ossification, pain; types of re-operation were open/closed reduction, soft tissue procedure, replacement - full or partial, stem reorientation, acetabular component reorientation, implant removal, excision heterotopic ossification and further fixation
Notes	**Funding/sponsor/declarations of interest:** supported by grants from the Canadian Institutes of Health Research, the National Institutes of Health, ZorgOnderzoek Nederland-Medische Wetenschappen (ZonMw), Sophies Minde Foundation for Orthopaedic Research, McMaster Surgical Associates, and Stryker Orthopaedics **Study dates:** January 2009 to May 2017 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Hedbeck 2011

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar
Participants	**Total number of randomised participants:** 120 **Inclusion criteria:** acute displaced femoral neck fracture (Garden III and IV); > 80 years of age; absence of severe cognitive dysfunction; independent living status; independent walking capability **Exclusion criteria:** pathological fractures; displaced fractures older than 48 hours; patients with rheumatoid arthritis or osteoarthritis **Setting:** single centre; hospital; Sweden **Intervention group 1** (bipolar) • Age, mean (SD, range): 85.5 (80 to 96) years • Gender, M/F, n: 18/42 • BMI, mean (range): 23.8 (17 to 33) kg/m^2 • Fracture classification, n: 100% displaced

Hedbeck 2011 *(Continued)*

- Mobility assessment, no walking aid/stick or crutches/walking frame, n: 46/7/7
- ASA status, I/II/III/IV, n: 0/30/29/1
- Cognitive status, SPMSQ, mean (SD, range): 9.0 (±0.8, 6 to 10)
- Additional information:
  - ADL, A or B, n: 58
  - EQ-5D, mean (range): 0.81 (0.16 to 1.0)

Intervention group 2 (unipolar)

- Age, mean (range): 87.4 (80 to 100)
- Gender, M/F: 11/49
- BMI, mean (range): 22.8 (17 to 38) kg/m^2
- Cognitive status/dementia, SPMSQ, mean (range): 8.5 (5 to 10)
- Fracture classification, n: 100% displaced
- Mobility assessment, no walking aid/stick or crutches/walking frame, n: 38/8/14
- ASA status, I/II/III/IV, n: 2/29/27/2
- Cognitive status, SPMSQ, mean (SD, range): 9.0 (± 0.8, 6 to 10)
- Additional information:
  - ADL, A or B, n: 58
  - EQ-5D, mean (range): 0.8 (0.16 to 1.0)

Note:

- study authors did not report: medication; place of residence; comorbidities; preoperative waiting time

Interventions	**General details:** 1 of 16 surgeons, all specialists in orthopaedic surgery experienced in both procedures; anterolateral approach; Exeter-stem (modular); low-molecular-weight heparin given preoperatively and for at least 10 days postoperatively; cloxacillin 2 g was given preoperatively, followed by 2 additional doses during the first 24 hours; mobilised with full weight bearing as tolerated; clinical follow-up at 4 months and 12 months **Intervention group 1** • HA bipolar (cemented); bipolar head (UHR®; Stryker Howmedica, Malmö, Sweden), available in dimensions from 44 mm to 72 mm • Randomised = 60; losses = 13 (4 died at 4 months; 13 died at 12 months and 1 lost to follow-up); analysed for mortality = 60; analysed for outcomes at 4 months = 56; analysed for outcomes at 12 months = 46 **Intervention group 2** • HA unipolar (cemented); Exeter stem (modular) with a unipolar head (Stryker Howmedica, Malmö, Sweden), available in dimensions from 41 mm to 56 mm • Randomised = 60; losses = 7 (1 died at 4 months; 7 died at 12 months); analysed for mortality = 60; analysed for outcomes at 4 months = 59; analysed for outcomes at 12 months = 53
Outcomes	**Outcomes measured/reported by study authors:** mortality; hip complications; general complications; ADL status (at 12 months); hip function (HHS; available at 4 months and 12 months); EQ-5D (available at 4 months and 12 months); independent living; perioperative parameters (blood loss, duration of surgery); dislocations, infection **Outcomes relevant to the review:** mortality (at 4 and 12 months); EQ-5D index (VAS not available; at 4 months and 12 months); unplanned return to theatre (at 12 months) **Notes:** • unplanned return to theatre: reasons for re-operation were dislocation, infection and periprosthetic fracture; types of re-operation were replacement with arthroplasty, open reduction, drainage of infection or haematoma

Hedbeck 2011 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** grants from the Trygg-Hansa Insurance Company and through the Regional Agreement on Medical Training and Clinical Research (ALF) between the Stockholm County Council and Karolinska Institutet **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details on method of randomisation
Allocation concealment (selection bias)	Low risk	Quote: "opaque sealed-envelope technique, independently prepared"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	The surgeons in the study were experienced in both techniques
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Not reported whether participants were blind to intervention, although unlikely to effect outcomes
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Hedbeck 2013

Study characteristics

Methods	RCT; parallel design **Review comparison group:** internal fixation (IF) versus HA

Hedbeck 2013 *(Continued)*

Participants	**Total number of randomised participants:** 60
	
	Inclusion criteria: ≥ 70 years of age; displaced femoral neck (Garden 3 or 4); cognitive dysfunction (SPMSQ < 3); OTA/AO type 31-B; walking with or without aids;
	
	Exclusion criteria: pathological fracture; osteoarthritis; fractures older than 24 hours
	
	Setting: single centre; hospital; Sweden
	
	Baseline characteristics
	
	Intervention group 1 (IF)
	
	• Age, mean (SD): 83.8 (± 5.4) years
	• Gender, M/F: 5/25
	• Mobility assessment, walking with no or one stick, n: 19
	• Cognitive status, SPMSQ mean (SD): 0.57 (± 0.86)
	• ASA status, class I or II, n: 10
	• Additional information:
	  ○ ADL, A or B, n: 5
	
	Intervention group 2 (HA)
	
	• Age, mean (SD): 85.2 (± 5.4) years
	• Gender, M/F: 5/24
	• Mobility assessment, walking with no or one stick, n: 16
	• Cognitive status, SPMSQ mean (SD): 0.62 (± 0.82)
	• ASA status, class I or II, n: 8
	• Additional information:
	  ○ ADL, A or B, n: 5
	
	Overall:
	
	• Age, mean (SD): 84.6 (± 5.5) years
	• Gender, M/F: 10/50
	
	Note:
	
	• authors did not report: smoking history, medication, BMI, comorbidities, place of residence

Interventions	**General details:** spinal anaesthetic; 19 surgeons all consultant orthopaedics; mobilised with weight bearing the day after surgery; 3 doses of cloxacillin and low-molecular-weight heparin as antibiotic and thromboembolic prophylactics; clinical follow-up at 4, 12 and 24 months **Intervention group 1:** • IF; two cannulated screws (Olmed 7.3 mm); closed reduction; hip traction table; anterolateral approach • Randomised = 30; for HRQoL: 20 reported at 4 months, 16 at 12 months **Intervention group 2:** • HA; Exeter; cemented; unipolar; • Randomised = 30; one lost due to incorrect diagnosis discovered intraoperatively; for HRQoL: 19 reported at 4 months, 17 at 12 months
Outcomes	**Outcomes measured/reported by study authors:** Function (Charnley); HRQoL (EQ-5D); mortality (all at 4, 12 and 24 months) operating duration; re-operations; complications: wound infection, pressure ulcer, DVT

Hedbeck 2013 *(Continued)*

	Outcomes relevant to the review: mortality (at 4, 12 months); unplanned return to theatre at 24 months; HRQoL (at 4, 12 months)
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** June 2005 to May 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation is not reported
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	Surgeons were all experienced, and we have assumed that they were experienced with both treatments in this study
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Study authors did not report whether participants were blinded to treatment allocation. However, we did not expect that lack of blinding would influence participants' assessment of their quality of life
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were mostly explained by death which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective outcome reporting bias without these documents

Herngren 1992

Study characteristics

Methods	RCT; parallel design **Review comparison groups:** screws versus smooth pins

Herngren 1992 *(Continued)*

Participants	**Total number of randomised participants/cases:** 179 participants/180 cases **Inclusion criteria:** people with femoral neck fractures **Exclusion criteria:** pathological fractures and fractures in children **Setting:** single centre; hospital; Sweden **Baseline characteristics** **Intervention group 1** (Uppsala screws) • Age: 77 (32 to 96) years (study authors do not report if this is a mean or median value, or whether it is range or IQR) • Gender, M/F: 35/61 • Place of residence, n: own home: 62; convalescent home: 1; almshouse (charity): 16; geriatric hospital: 6; nursing home: 6; hospital: 2; other: 1; nursed in another department: 1; unknown: 0 • Mobility assessment, walking aids before fracture, n: none: 56; 1 crutch: 4; 2 crutches: 3; 1 crutch and one quadruped: 0; 2 quadrupeds: 0; walking frame: 30; wheelchair: 1; not walking: 1 • Cognitive status, n: well: 58; do not remember which day: 14; do not remember where they live: 7; do not remember their name: 5; missing data: 11 • Fracture classification, undisplaced/displaced, n: 25/71 **Intervention group 2** (Hansson pins) • Age: 78 (28 to 97) years (study authors do not report if this is a mean or median value, or whether it is range or IQR) • Gender, M/F: 32/52 • Place of residence, n: own home: 61; convalescent home: 0; almshouse (charity): 11; geriatric hospital: 7; nursing home: 3; hospital: 2; other: 0; nursed in another department: 0; unknown: 0 • Mobility assessment, walking aids before fracture, n: none: 54; 1 crutch: 16; 2 crutches: 0; 1 crutch and one quadruped: 0; 2 quadrupeds: 0; walking frame: 7; wheelchair: 2; not walking: 2; missing data: 3 • Cognitive status, n: well: 50; do not remember which day: 8; do not remember where they live: 4; do not remember their name: 11; missing data: 11 • Fracture classification, undisplaced/displaced, n: 25/59 **Overall** • Mobility assessment/use of walking aides: 51% able to walk outside without any walking aids • Place of residence: 83% lived in their own home • Cognitive status/dementia: 59% had good prefracture mental status • Preoperative waiting time: quote: "patients were operated on within 24 (1-100) hours of admission" **Note:** • study authors did not report the following baseline characteristics: smoking history, medication, BMI, comorbidities, or ASA status. • we could not be certain if prognostic factors at baseline were comparable because study authors reported few baseline characteristics for each group
Interventions	**General details:** displaced fractures were treated with traction; 20 surgeons were responsible for operations (all were trained in both surgical techniques). Immediate full weight bearing was encouraged; clinical and radiographic follow-up examinations were done after 5 (3 to 8) months and 13 (9 to 25 months) **Intervention group 1** • 2 Uppsala screws • Randomised = 95 participants (96 cases); reported losses = 3 (did not attend follow-up appointments due to poor health); analysed for mortality = 95; analysed for re-operations = 96

Herngren 1992 *(Continued)*

	Intervention group 2 • 2 Hannson pins • Randomised = 84 participants (84 cases); reported losses = 2 (did not attend follow-up appointments due to poor health); analysed = 84 **Note:** • study authors did not report the following intervention details: use of prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** complications (union, non-union, segmental collapse defined as including AVN, fracture displacement); re-operations; local discomfort due to protruding screws; deep infection; penetration perioperatively into the cartilage, trochanteric fracture on the same side; mortality; pain **Outcomes relevant to the review:** mortality (12 months); unplanned return to theatre (12 months) **Note:** • unplanned return to theatre: reasons for re-operation were deep infection, segmental collapse, non-union or second fracture; types of re-operation were removal of fixation
Notes	**Funding/sponsor/declarations of interest:** financial support from Skandia Insurance company and the Jämtland County Council **Study dates:** July 1988 to June 1989 **Note:** • participant data were reported individually in a single table. For some baseline characteristics and outcome data, we calculated mean values or counted number of events per group

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Simple randomisation with a single sequence of random numbers
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Surgeons were trained to use both implants but it is not clear whether the surgeons were equally experienced in using both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective

Herngren 1992 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors reported that 5 participants did not attend follow-up, and did not report data for those who died. However, data were not reported completely for all participants that did not die for most outcomes. We noted a high loss to follow-up for pain
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective outcome reporting bias without these documents

Holmberg 1990

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** smooth pin versus smooth pin
Participants	**Total number of randomised participants:** 220 **Inclusion criteria:** non-pathological intracapsular femoral neck fractures **Exclusion criteria:** pathological fractures **Setting:** single centre; hospital; Sweden **Baseline characteristics** **Intervention group 1** (Rydell nail) • Age, mean (SD): 78 years • Gender, M/F: 28/82 • Place of residence (home/institution): 84/26 • Fracture classification, undisplaced/displaced: 41/69 **Intervention group 2** (LIH hook pins) • Age, mean (SD): 79 years • Gender, M/F: 27/83 • Place of residence (home/institution): 80/30 • Fracture classification, undisplaced/displaced: 37/73 **Note:** • study authors did not report any baseline data for: smoking history, BMI, mobility assessment, cognitive status, preoperative waiting time
Interventions	**General details:** specialist surgeons who had been using pins for 6 months; closed reduction and internal fixation; surgery usually within 24 hours; early weight bearing **Intervention group 1** • Rydell nail • Randomised = 110 **Intervention group 2** • LIH hook pins

Holmberg 1990 *(Continued)*

	• Randomised = 110
Outcomes	**Outcomes measured/reported by study authors:** mortality; displacement/non-union/osteonecrosis; noted: radiographic outcomes at 6, 12 and 24 months but not reported **Outcomes relevant to the review:** mortality (24 months)
Notes	**Funding/sponsor/declarations of interest:** financially supported by Clas Groschinsky's foundation and by Stockholm County Council **Study dates:** February 1986 to March 1987 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Ingwersen 1992

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus screw
Participants	**Total number of randomised participants:** 100 **Inclusion criteria:** cervical hip fractures **Exclusion criteria:** not reported **Setting:** single centre; hospital; Norway **Baseline characteristics not reported** - study reported only as an abstract **Note:** • study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups; they state that the groups were comparable
Interventions	**General details:** none reported, abstract only **Intervention group 1** • Olmed - two screws (6 mm) • Number randomised to each group was not reported **Intervention group 2** • Richard fixation - two screws (5 mm) • Number randomised to each group was not reported
Outcomes	**Outcomes measured/reported by study authors:** re-operation and redislocation, from radiographs, 3 (range 2 to 6) months; deep infection **Outcomes relevant to the review:** unplanned return to theatre **Note:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation not reported

Ingwersen 1992 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** "during 1990" **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Inngul 2015

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA & HA: cemented versus uncemented • Patients aged between 65 and 79 years were allocated to treatment with either a cemented THA or a reverse hybrid THA. • Patients aged > 80 years were allocated to treatment with either a cemented or an uncemented unipolar HA • Owing to slow recruitment, a decision was made in November 2012 to pool the two studies

Participants	**Total number of randomised participants:** 141
	
	Inclusion criteria: acute, displaced (Garden's III or IV) fracture of the femoral neck following low-energy trauma
	
	Exclusion criteria: patients who sustained a fracture > 48 hours before admission and those with rheumatoid arthritis and symptomatic osteoarthritis
	
	Setting: single centre; hospital; Sweden
	
	Intervention group 1 (cemented)
	
	• Age, mean (range): 81.2 (65 to 96) years
	• Gender, M/F, n: 21/46
	• Cognitive status/dementia, SPMSQ, mean (range): 9.3 (5 to 10)
	• Fracture classification, n: 100% displaced
	• Mobility assessment, no walking aid (or just 1 stick), n: 56
	• ASA status, I or II: 35
	• Additional information:
	  ◦ ADL, using Katz (category A), n: 63
	
	Intervention group 2 (uncemented)
	
	• Age, mean (SD, range): 81.3 (66 to 93) years
	• Gender, M/F, n: 21/53
	• Cognitive status/dementia, SPMSQ, mean (range): 9.0 (6 to 10)
	• Fracture classification, n: 100% displaced
	• Mobility assessment, no walking aid (or just 1 stick), n: 57
	• ASA status, I or II, n: 32
	• Additional information:
	  ◦ ADL, using Katz (category A), n: 66
	
	Note:

Inngul 2015 *(Continued)*

- study authors did not report: medication; place of residence; comorbidities; preoperative waiting time

Interventions	**General details:** performed by consultant orthopaedic surgeons experienced in the use of cemented and uncemented stems; lateral decubitus position via a direct lateral approach; spinal anaesthesia; prophylactic antibiotics 30 to 60 minutes preoperatively, and 3 and 6 hours later; low molecular heparin, postoperatively and continued for 30 days; weight bearing as tolerated **Intervention group 1** • Cemented Exeter stem (Stryker Howmedica, Kalamazoo, USA) with either a unipolar head or a 32 mm head and a cemented cross-linked polyethylene (XLPE) Marathon cup (THA patients) (DePuy/Johnson & Johnson, Warsaw, Indiana); group includes 39 participants who had HA, and 28 participants who had THA • Randomised = 67 **Intervention group 2** • Hydroxyapatite-coated Bimetric stem (Biomet, Warsaw, USA) with either a unipolar head (HA patients) or a 32 mm head and a cemented XLPE Marathon cup (THA patients) was used; all cemented implants gentamicin-loaded Optipac (Biomet) bone cement; group includes 44 participants who had HA, and 30 participants who had THA • Randomised = 74
Outcomes	**Outcomes measured/reported by study authors:** HRQoL questionnaire (EQ-5D); SMFA; HHS; bleeding and operating time; adverse events; postoperative heterotopic ossification; acetabular erosion; mortality (4 months and 12 months); intra-operative femoral fracture; intra-operative fracture of the tip of the greater trochanter **Outcomes relevant to the review:** unplanned return to theatre (for dislocation, periprosthetic fracture and for deep infection); HRQoL (EQ-5D); mortality **Notes:** • unplanned return to theatre: reasons for re-operation were dislocation and periprosthetic fracture; types of re-operation included 1 revision to THA; data reported from the combined totals at 12 and 48 months
Notes	**Funding/sponsor/declarations of interest:** no commercial funding **Study dates:** October 2009 to April 2013 **Note:** • we attempted to contact study authors by email but email address is no longer active • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Iorio 2019

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:**THA (with dual-mobility cup) versus HA
Participants	**Total number of randomised participants:** 60 **Inclusion criteria:** displaced intracapsular fracture (Garden III or IV); dementia diagnosis made by a professional Geriatric Assessment Team (DSM-5 criteria); Mini-Mental Test score < 18; patients > 60 years of age; able to walk unaided before fracture

Iorio 2019 *(Continued)*

Exclusion criteria: pathological fracture secondary to malignant disease; concomitant fracture requiring surgery

Setting: single centre; hospital; Italy

Intervention group 1 (THA)

- Age, mean (± SD): 82 (± 4) years
- Gender, M/F, n: 12/18
- ASA status, II/III/IV, n: 3/23/4
- Time to surgery, median (range): 59 (16 to 68) hours

Intervention group 2 (HA)

- Age, mean (± SD): 83 (± 3) years
- Gender, M/F, n: 13/17
- ASA status, II/III/IV, n: 4/21/5
- Time to surgery, median (range): 51 (12 to 72) hours

Note:

- study authors did not report: BMI; smoking; medication; place of residence; comorbidities; preoperative waiting time

Interventions	**General details:** antibiotic and venous thromboembolic prophylaxis; direct lateral approach; weight bearing was allowed (POD2); guided rehabilitation protocol **Intervention group 1** • THA; dual-mobility cup Quattro (Groupe Lépine, Genay, France) with Pavi cementless femoral stem (Groupe Lépine) • Randomised = 30; losses = 4 (died at 12 months); analysed = 30 **Intervention group 2** • HA; Excia cementless femoral stem with bipolar head (Braun, Aesculap, Tuttlingen, Germany) • Randomised = 30; losses = 5 (died at 12 months); analysed = 30
Outcomes	**Outcomes measured/reported by study authors:** dislocation; re-operation rate; time to surgery; surgical time; length of hospital stay (available at 30 days and 1 year) **Outcomes relevant to the review:** mortality (at 30 days and 1 year); unplanned return to theatre (re-operation) **Notes:** • unplanned return to theatre: reasons for re-operation were infection; types of re-operation were not reported
Notes	**Funding/sponsor/declarations of interest:** funding not reported. Study authors declare no conflicts of interest **Study dates:** October 2015 to September 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Allocated "with an alternate assignment on the basis of their order of admission"

Iorio 2019 *(Continued)*

Allocation concealment (selection bias)	High risk	Not possible to conceal an alternate allocation method
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Jeffcote 2010

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar

Participants	**Total number of randomised participants:** 51 participants (52 hip fractures)
	
	Inclusion criteria: displaced (Garden's III and IV) subcapital fracture
	
	Exclusion criteria: < 60 years of age; significant arthritic change; pathological fracture; living outside the metropolitan area
	
	Setting: single centre; hospital; Australia
	
	Intervention group 1 (bipolar)
	
	• Age, mean: 80.1 years
	• Gender, M/F, n: 6/18
	• Additional information (scores relating to pre-injury status were obtained in the postoperative week):
	  ○ Initial HHS, mean: 71
	  ○ WOMAC, mean: 88
	
	Intervention group 2 (unipolar)

Jeffcote 2010 *(Continued)*

- Age, mean: 81.4 years
- Gender, M/F, n: 6/21
- Additional information (scores relating to pre-injury status were obtained in the postoperative week):
  - Initial HHS, mean: 72
  - WOMAC, mean: 85

Note:

- study authors did not report: BMI, medication; place of residence; comorbidities; preoperative waiting time

Interventions	**General details:** cemented Exeter femoral stem (Stryker, Kalamazoo, MI, USA); performed by consultants or registrars; postoperative 24 hour IV antibiotics, thromboprophylaxis, early mobilisation; follow-up with radiographs at first week postoperatively and at 3, 12 and 24 months **Intervention group 1** • HA bipolar; Centrax head • Randomised = 24 patients (25 hips); analysed = 24 **Intervention group 2** • HA unipolar; Unitrax head • Randomised = 27; analysed = 27 **Notes:** • 10 participants withdrew (unclear how these were allocated to intervention groups); 4 occurred within 3 months; a further 4 up to 2 years; 2 were not contactable • 37/51 completed 3 months; 30/51 completed 12 months; 23/51 completed 24 months
Outcomes	**Outcomes measured/reported by study authors:** HHS; WOMAC; migration of the HA head; 6MWT (available at 3, 12, and 24 months); mortality (3 months and 2 years) **Outcomes relevant to the review:** mortality (at 2 years) **Notes:** • we did not included mortality data at 3 months because this was reported as an overall number rather than by group
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** April 2001 and August 2003

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "randomly allocated to either the bipolar or unipolar group using a list with random numbers" Comment: it is unclear how the random numbers were generated
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance

Jeffcote 2010 *(Continued)*

Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	We noted a large loss to follow-up at 12 and 24 months, but we did not extract data for these outcomes because the data were not clearly reported. We included only data for mortality which was complete
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors did not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Johansson 2014

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** internal fixation (IF) versus THA
Participants	**Total number of randomised participants:** 143 patients (146 hips); 3 participants were randomised twice and were fully recovered after the first fracture treatment **Inclusion criteria:** ≥ age of 75 years or older; displaced femoral fracture; an ability to walk prior to the fracture; no rheumatic joint disease; no contraindication to major surgery **Exclusion criteria:** not reported **Setting:** single centre; hospital; Sweden **Baseline characteristics** **Overall:** • Age, mean (range): 84 (75 to 101) years • Gender, M/F: 32/111 • Cognitive status, mentally impaired, n: 55 **Note:** • Study authors did not report baseline characteristics for each group, or overall data for: smoking history, medication, BMI, comorbidities, mobility, place of residence, ASA status, pre-operative waiting time
Interventions	**General details:** operation performed on the day after admittance; IF was performed by 25 different surgeons and THA by 22; clinical follow-up at 3 months and annually thereafter **Intervention group 1:** • IF; 2 parallel and percutaneously inserted screws (Olmed; DePuy/Johnson & Johnson); closed reduction with the aid of 2-plane fluoroscopy • Randomised = 78, no loss to follow-up reported; analysed = 78

Johansson 2014 *(Continued)*

	Intervention group 2: • THA; cemented Lubinus IP; using a posterolateral approach • Randomised = 68, no loss to follow-up reported; analysed = 68 **Note:** • Study authors did not reported the following details: type of anaesthesia, pre- and postoperative care (e.g. use of prophylactic antibiotics or antithromboembolics), rehabilitation (e.g. time to mobilisation or weight bearing)
Outcomes	**Outcomes measured/reported by study authors:** functional status (HHS); wound infection; dislocation; failure; re-operation; mortality (data available at 3, 12, 24 and 36 months) **Outcomes relevant to the review:** mortality (reported at 3, 12 and 36 months); unplanned return to theatre (all re-operations performed within 2 years of primary procedure but 4 to 8 year follow-up)
Notes	**Funding/sponsorship/declarations of interest:** conflicts of interest were not reported **Study dates:** September 1994 to May 1998 **Note:** • multiple study reports are available. We selected the 2014 paper as the primary source because it reports data for 143 participants (earlier papers report data for 100 participants). This is consistent with numbers consenting to inclusion in the nutritional arm of this study which is described in the linked thesis publication (Johansson 2002).

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation is not described
Allocation concealment (selection bias)	Unclear risk	Quote: "consecutively enrolled and randomized, using sealed envelopes" Comments: study authors do not describe if envelopes are opaque and sequentially-numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to interventions. We did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Number of surgeons for each treatment is reported, but we could not determine if they were equally experienced with both treatments in the study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not believe that lack of blinding would influence data for this outcome
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias)	Low risk	No apparent loss to follow-up

Johansson 2014 *(Continued)*
All outcomes

Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trial registration or prepublished protocol; it is not feasible to effectively assess risk of reporting bias without these documents

Jonsson 1996

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** internal fixation vs THA
Participants	**Total number of randomised participants:** 50 **Inclusion criteria:** displaced cervical hip fractures, Gardens III or IV; living in own home and fully ambulatory before fracture; fracture had to be < 48 hours old on admission to hospital **Exclusion criteria:** not reported **Setting:** single-centre; hospital; Sweden **Baseline characteristics** (only for analysed participants) **Intervention group 1** (internal fixation) • Age, median (does not report type of distribution): 79 (70 to 89) years • Gender, M/F: 6/18 • Pre-operative waiting time: usually undergone surgery on the day following admissions **Intervention group 2** (THA) • Age, median (does not report type of distribution): 80 (67 to 89) years • Gender, M/F: 5/18 • Pre-operative waiting time: usually undergone surgery on the day following admissions **Note:** • study authors do not report baseline characteristics for: smoking history, medication, BMI, comorbidities, cognitive status, ASA status • we were uncertain whether prognostic variables were comparable between groups because study authors reported insufficient information
Interventions	**General details:** no general details reported; clinical follow-up at 1, 4, 12, and 24 months postoperatively **Intervention group 1** • IF; Hannson hook pins; closed reduction • number randomised = 25; losses = 1 (reason for exclusion is unclearly reported, either because of unexpected deterioration in condition, or because of misclassification of the fracture); analysed = 24 **Intervention group 2** • THA with Charnley prosthesis

Jonsson 1996 *(Continued)*

- number randomised = 25, losses = 2 (reason for exclusion is unclearly reported, either because of unexpected deterioration in condition, or because of misclassification of the fracture); analysed = 23

Note:

- study authors do not report number of surgeons (and their skills and experience), type of anaesthesia, use of prophylactic antibiotics or antithromboembolics, or postoperative mobility or weight-bearing regimens

Outcomes	**Outcomes measured/reported by study authors:** mortality (at 24 months); revision surgery (at 24 months); complications (confusion, superficial infection, DVT, pulmonary embolism, bed sores, UTI, MI, heart failure, postoperative dislocation); ambulation (use of walking aids); able to do own shopping; walking distance; pain; use of analgesics; home assistance **Outcomes relevant to the review:** mortality (at 24 months); unplanned return to theatre (replacement surgery in internal fixation group, revision surgery in THA group; at 24 months)
Notes	**Funding/sponsorship/declarations of interest:** financial support from the Swedish Medical Society and the Herman Järnhardt and Greta and Johan Kock Foundations **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "The randomization was performed by drawing a sealed envelope specifying the operation method selected" Comment: insufficient information
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes; however, study authors do not report if envelopes are opaque or sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to intervention groups. However, we did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	The number of surgeons and their skills and experience with both implants is not reported
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few losses which were reported and balanced between groups
Other bias	Low risk	We identified no other sources of bias

Jonsson 1996 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trial registration or pre-published protocol. It is not feasible to effectively assess risk of reporting bias without these documents

Kalland 2019

Study characteristics	
Methods	RCT; parallel group **Review comparison group:** smooth pins versus fixed angle plate

Participants	**Total number of randomised participants:** 538
	
	Inclusion criteria: ≥ 50 years of age; femoral neck fracture
	
	Exclusion criteria: "Patients with prior inclusion in the study presenting with a fracture in the contralateral hip were not included in the study with the new fracture"
	
	Setting: 9 orthopaedic departments in Sweden; stratified according to orthopaedic department and fracture type: undisplaced/displaced
	
	Baseline characteristics
	
	Intervention group 1 (Hansson pins, for analysed participants)
	
	• Age, mean (IQR):
	  ◦ Undisplaced fractures: 80 (71 to 87) years
	  ◦ Displaced fractures (50-69 years group): 62 (58 to 65) years
	  ◦ Displaced fractures (≥ 70 years group): 82 (77 to 87) years
	• Gender, M/F: 70/140
	• Dementia, n:
	  ◦ Undisplaced fractures: 19
	  ◦ Displaced fractures (50 to 69 years group): 1
	  ◦ Displaced fractures (≥ 70 years group): 5
	• Smoking, n: 34
	• Medication, corticosteroids, n: 9
	• BMI, mean (SD):
	  ◦ Undisplaced fractures: 23 (± 4) kg/m^2
	  ◦ Displaced fractures (50-69 years group): 26 (± 5) kg/m^2
	  ◦ Displaced fractures (≥ 70 years group): 25 (± 4) kg/m^2
	• Medication, corticosteroids, n: 9
	• Fracture classification, undisplaced/displaced, n: 156/54
	
	Intervention group 2 (Pinloc, for analysed participants)
	
	• Age, mean (IQR):
	  ◦ Undisplaced fractures: 80 (73 to 86) years
	  ◦ Displaced fractures (50 to 69 years group): 59 (56 to 64) years
	  ◦ Displaced fractures (≥ 70 years group): 84 (78 to 87) years
	• Gender, M/F: 66/163
	• Dementia, n:
	  ◦ Undisplaced fractures: 31
	  ◦ Displaced fractures (50 to 69 years group): 0
	  ◦ Displaced fractures (≥ 70 years group): 7

Kalland 2019 *(Continued)*

- Smoking, n: 34
- BMI, mean (SD):
  - Undisplaced fractures: 24 (± 4) kg/m^2
  - Displaced fractures (50 to 69 years group): 25 (± 4) kg/m^2
  - Displaced fractures(≥ 70 years group): 25 (± 4) kg/m^2
- Medication, corticosteroids, n: 15
- Fracture classification, undisplaced/displaced, n: 169/60

Interventions	**General details:** full weight bearing postoperatively **Intervention group 1** • Hansson pins - 2 standard Hansson pins • Randomised = 264; losses = 51 (1 did not receive intervention, 4 lost to follow-up, 46 deemed unfit for follow-up by participant or relative, or withdrew consent); analysed = 210 **Intervention group 2** • Pinloc - 3 cylindrical parallel pins with hooks, connected through a fixed angle interlocking plate, which is not attached to the femoral shaft • Randomised = 274; losses = 45 (1 did not receive intervention, 1 lost to follow-up, 43 deemed unfit for follow-up by participant or relative, or withdrew consent); analysed = 229
Outcomes	**Outcomes measured/reported by study authors**: WOMAC, EQ-5D-3L, early displacement, non-union, AVN, deep infection, re-operation **Outcomes relevant to the review:** mortality (12 months); unplanned return to theatre **Notes:** • 3 and 12 months follow-up; • we attempted contact with the study authors for EQ-5D-3L but we did not receive a reply • unplanned return to theatre: reasons for re-operation were deep infection; types of re-operation were replacement with arthroplasty, removal of fixation, resection of femoral head, or refixation
Notes	**Funding/sponsor/declarations of interest:** funded by Region Östergötland, no conflicts declared **Study dates:** May 2014 to February 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomised but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were experienced in both techniques

Kalland 2019 *(Continued)*

Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	High risk	High proportion lost to follow-up due to being deemed unfit for follow-up by participant or relative, or withdrew consent. We could not be certain whether this influenced outcome data
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study registered with a clinical trials register (NCT02776631; first received January 2016), study authors do not report prepublished protocol. Study commenced prior to registration so unable to effectively assess risk of selective reporting bias

Kanto 2014

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar

Participants	**Total number of randomised participants:** 175
	
	Inclusion criteria: > 65 years; displaced (Garden III to IV) femoral neck fracture; enrolled in the study within 24 hours of hospital admission
	
	Exclusion criteria: < 65 years; fracture of pathological origin; non-displaced (Garden I to II) fracture; alcohol or drug abuse; cognitively unintact; known bone diseases or known malignancy; high-energy trauma; rheumatoid arthritis; osteoarthritis
	
	Setting: 2 trauma centres, 1 secondary trauma centre and 1 tertiary trauma centre; Finland
	
	Intervention group 1 (bipolar; data are incomplete for gender which is unexplained by study authors)
	
	• Age, mean (± SD): 81.7 (±6.0)
	• Gender, M/F, n: 14/72
	• BMI, mean (SD): 23.8 (± 3.7) kg/m^2
	• Comorbidities, type, %:
	  ○ no fracture: 75
	  ○ distal radius: 6
	  ○ vertebrae: 4
	  ○ proximal humerus: 1
	• Mobility assessment/use of walking aides, n:
	  ○ independent community ambulatory with regular exercise: 16
	  ○ independent community ambulatory: 37
	  ○ independent household ambulatory: 12
	  ○ household ambulator with cane: 13
	  ○ household ambulator with walker/crutches: 18
	  ○ assisted ambulation only: 4

Kanto 2014 *(Continued)*

- ASA status, I/II and III/V, n: 15 and 85
- Fracture classification, n: 100% displaced

Intervention group 2 (unipolar)

- Age, mean (± SD): 83.9 (± 6.5) years
- Gender, M/F,n: 16/72
- BMI, mean (SD): 24.7 (± 3.9)
- Comorbidities, type, %:
  - no fracture: 82
  - distal radius: 7
  - vertebrae: 0
  - proximal humerus: 0
- Mobility assessment/use of walking aides, n:
  - independent community ambulatory with regular exercise: 17
  - independent community ambulatory: 33
  - independent household ambulatory: 21
  - household ambulator with cane: 11
  - household ambulator with walker/ crutches: 19
  - assisted ambulation only: 0
- ASA status, I/II and III/IV, n: 11 and 89
- Fracture classification, n: 100% displaced

Note:

- study authors did not report: medication; place of residence; preoperative waiting time

Interventions	**General details:** cemented Lubinus SP II stem (Waldemar Link GmbH & Co, Hamburg, Germany); posterior decubitus approach; lateral position; cemented with Palacos cum gentamycin antibiotic cement (Heraeus Holding GmbH, Hanau, Germany); multiple surgeons performed the operations - senior consultants 27%, orthopaedic residents 73%; spinal anaesthesia; preoperative prophylactic cefuroxime or clindamycin in case of cefuroxime allergy was infused 30 min prior to surgery; low-molecular-weight miniheparin starting at 6 hours preoperatively and continuing for 4 weeks postoperatively except those with permanent preoperative warfarin treatment when miniheparin was given until the international normalisation ratio (INR) had been between 2 and 3 for 2 days; patients were mobilised to full weight bearing as tolerated **Intervention group 1** • HA bipolar; Vario-Cup; heads were available in sizes from 38 mm to 60 mm; size of the inner head of the bipolar prosthesis was 28 mm • Randomised = 87; analysed = 87 **Intervention group 2** • HA unipolar; heads were available in sizes from 38 mm to 60 mm • Randomised = 88; analysed = 88
Outcomes	**Outcomes measured/reported by study authors:** implant survival, with revision; mortality (reported in hospital, and at 1, 3, 12 months, and 3 and 5 years); categories of ambulatory ability; general complications; radiographic analysis; operating time; estimated blood loss; dislocations; protrusion; revisions **Outcomes relevant to the review:** mortality (in hospital, and at 5 years); unplanned return to theatre (revision); dislocation **Notes:** • we were only able to extract mortality data at two time points (in hospital and at 5 years); we could not calculate data for the other times points which were reported for both groups combined

Kanto 2014 *(Continued)*

- unplanned return to theatre: reasons for re-operation were dislocation; types of re-operation were replacement with arthroplasty

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** March 2003 and November 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Low risk	Quote: "consecutively numbered and sealed opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that all the interventions were performed by senior consultants or orthopaedic residents but we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Retrospective registration with a clinical trials register (ACTRN12613000092796, first received in 2013). It is not feasible to use these documents to effectively assess risk of selective reporting bias

Keating 2006

Study characteristics

Methods	RCT; parallel design **Review comparison group:** THA versus HA **Note:** • study included 2 separate comparison groups: HA vs internal fixation (IF) and a 3-arm comparison (HA vs internal fixation vs THA). Study authors did not explain why participants were randomised to the

Keating 2006 *(Continued)*

	2-way or 3-way groups. Because study authors reported combined data from the HA groups, we have therefore reported these together in the review. We did not include the data from the internal fixation groups in this NMA due to the mixed nature of the IF implants.
Participants	**Total number of randomised participants:** 180 **Inclusion criteria:** displaced intracapsular hip fracture; normal cognitive function (a mini-mental test score of > 6), an ability to be mobile independent of another person prior to the fracture, and no serious concomitant disease (or other clinical reason for exclusion) **Exclusion criteria:** undisplaced or valgus impacted intracapsular fracture; "if a surgeon believed that a particular procedure was clearly indicated or clearly contraindicated, then that patient was not eligible for the trial" **Setting:** 11 orthopaedic units; 5 university-affiliated teaching hospitals, 6 district general hospitals; UK **Intervention group 1** (THA) • Age, mean (± SD): 75.2 (± 6) • Gender, M/F: 17/52 • Fracture classification, n: 100% displaced **Intervention group 2** (HA) • Age, mean (± SD): 75.4 (±7) • Gender, M/F: 19/92 • Fracture classification, n: 100% displaced **Intervention group 3** (IF) • Age, mean (± SD): 74.9 (±7) • Gender, M/F: 29/89 • Fracture classification, n: 100% displaced **Note:** • study authors did not report: BMI; medication; comorbidities; mobility assessment; place of residence; preoperative waiting time • all participants at least 60 years of age
Interventions	**General details:** 46 surgeons; surgical approach (lateral or posterior) for the arthroplasty, the type of cemented implant, and the use of antibiotics or thromboprophylaxis, were made by the treating surgeon **Intervention group 1** • THA, cemented. Type of implant was made at the discretion of attending surgeon • Randomised = 69; 58 received THA, 7 HA, 4 other; reported as ITT; analysed for HRQoL = 66; analysed for other outcomes = 69 **Intervention group 2** • HA bipolar, cemented hemiarthroplasty • Randomised = 111; 107 received HA, 4 other; reported as ITT; analysed for HRQoL = 102; analysed for other outcomes = 111 **Intervention group 3** • IF, surgeon's preference • Randomised = 118; 102 received IF, 16 other

Keating 2006 *(Continued)*

Outcomes	**Outcomes measured/reported by study authors:** hip-rating questionnaire (100-point scale across 4 domains: global, pain, walking, function; available at 4, 12, and 24 months); HRQoL (using EQ-5D; available at 4, 12, 24 months); mortality (at 4 months and 24 months); re-admission; re-operation; fixation failure; non-union; osteonecrosis; prosthetic dislocation; postoperative complications: wound infection, septicaemia, deep venous thrombosis, pulmonary embolism, stroke, and MI; blood transfusion; discharge destination; length of stay **Outcomes relevant to the review:** HRQoL using EQ-5D (utility index score, no VAS reported) at 4 and 12 months; mortality (at 4 months and 24 months), unplanned return to theatre (re-operation) **Notes:** • data taken from total recruited for HA rather than smaller subgroup used in the analysis in the paper • unplanned return to theatre: reasons for re-operation were dislocation and infection; types of re-operation were not reported
Notes	**Funding/sponsor/declarations of interest:** National Health Service R&D Health Technology Assessment Programme **Study dates:** June 1996 to May 2000 (recruitment period) **Note:** • also known as the STARS study

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	We noted 3 levels to the randomisation process, with high risk of bias in the initial decision to allocate participants to a 3-arm comparison (to include internal fixation) or to a 2-arm comparison using the surgeon's decision on selection. Once selected to a comparison group, allocation was completed using a centralised, computer-based system.
Allocation concealment (selection bias)	High risk	Because of the initial selection process, we have judged this to be high risk of selection bias. However, we acknowledge that the second process of randomisation to treatment groups (using a centralised system) indicated low risk of bias
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	The senior surgeon ensured that all procedures were performed by surgeons who were sufficiently competent
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Study authors did not report whether participants were blinded to treatment allocation. However, we did not expect that lack of blinding would influence participants' assessment of their quality of life
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias):	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective

Keating 2006 *(Continued)*

unplanned return to theatre		
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was not explained, but ITT analysis was used, and we noted few losses in both groups
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Kim 2012

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA: short stem versus conventional stem
Participants	**Total number of randomised participants:** 161 **Inclusion criteria:** acute Garden III or IV fracture of the femoral neck **Exclusion criteria:** none reported **Setting:** single centre; hospital; South Korea **Intervention group 1** (THA - short; reported for analysed participants) • Age, mean (± SD, range): 74.9 (± 4.92, 50 to 94) • Gender, M/F,n: 19/51 • BMI, mean (SD, range): 25.1 (± 5.9, 19 to 31) kg/m^2 • Fracture classification, n: 100% displaced. Garden's III/IV, n: 22/48 **Intervention group 2** (THA - conventional; reported for analysed participants) • Age, mean (± SD, range): 76 (± 5.13, 55 to 96) • Gender, M/F, n: 17/53 • BMI, mean (SD, range): 24.7 (± 3.6, 16.7 to 34.1) kg/m^2 • Fracture classification, n: 100% displaced. Garden's III/IV, n: 26/44 **Note:** • study authors did not report: smoking history, medication comorbidities, mobility, place of residence, cognitive status, ASA status, preoperative waiting time
Interventions	**General details:** both groups received a cementless Pinnacle acetabular component (DePuy) with a 36 mm inner diameter Biolox delta ceramic liner (CeramTec); 2 surgeons had experience with each of the 2 stems in more than 200 implantations with each of the stems under investigation; posterolateral approach; mobilised on the second postoperative day; follow-up at 3 months, 1 year and yearly thereafter **Intervention group 1** • THA, short, anatomical metaphyseal-fitting cementless femoral component (Proxima; DePuy, Leeds, United Kingdom) with a 36 mm Biolox delta ceramic modular head (CeramTec AG, Plochingen, Germany); cementless Pinnacle acetabular component

Kim 2012 *(Continued)*

	• Randomised = 81 **Intervention group 2** • THA, anatomical medullary locking fully porous coated cementless femoral component (DePuy, Warsaw, Indiana) with the 36 mm Biolox delta ceramic modular head • Randomised = 80 **Notes:** 161 recruited, 11 died, 10 lost to follow-up at 24 months
Outcomes	**Outcomes measured/reported by study authors:** HHS; WOMAC; thigh pain (10-point visual analogue scale, where 0 represents no pain and 10 severe pain); activity level using UCLA score; adverse events; acute kidney injury; pneumonia; transfusion reaction; mental status change; pulmonary; fracture; dislocation; superficial infection; pain; walking ability **Outcomes relevant to the review:** mortality
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** November 2006 and November 2009 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Kuokkanen 1991

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Total number of randomised participants:** 33 **Inclusion criteria:** non-pathological, non-dislocated or minimally dislocated, Garden's I and II fractures of the femoral neck **Exclusion criteria:** not reported **Setting:** single centre; hospital; Finland **Baseline characteristics** **Intervention group 1** (Mecron screws) • Age, mean or median (range): 72.5 (62 to 82) years • Fracture classification, undisplaced/displaced Garden's I, n: 7; Gardens's II, n: 9 **Intervention group 2** (Richards fixed angle plate) • Age, mean or median (range): 60 (21 to 84) years • Fracture classification, undisplaced/displaced, Garden's I, n: 4; Garden's II, n: 13 **Overall** • Gender, M/F: 7/26 **Notes:**

Kuokkanen 1991 *(Continued)*

- study authors did not report the following baseline characteristics: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence; cognitive status, ASA status, preoperative waiting time

Interventions	**General details:** operations performed almost exclusively by younger staff surgeons; full postoperative weight bearing on POD1 **Intervention group 1** • 3 cannulated cancellous bone screws (Mecron) • Randomised = 16; loss = 1 (for HHS, we assumed this was owing to death); analysed = 16 **Intervention group 2** • Richards screw-angle plate • Randomised = 17; loss = 3 (for HHS, we assumed this was owing to death); analysed = 17 **Note:** • study authors did not report intervention details for the following: number of clinicians, type of anaesthesia, use of prophylactic antibiotics or antithromboembolics, or use of traction
Outcomes	**Outcomes measured/reported by study authors:** mortality, complications (failure of osteosynthesis, asymptomatic caput necrosis, symptomatic caput necrosis, delayed ossification, DVT, postoperative hemiplegia; infections), re-operation; functional status **Outcomes relevant to the review:** mortality (at < 30 days; at end of follow-up which was a mean (range) 21 (14 to 29 months)); unplanned return to theatre **Note:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty or removal of fixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** January 1985 to July 1986

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation was not described
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It was not possible to blind surgeons to types of interventions but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Surgery was performed by younger staff surgeons. Study authors do not report whether these surgeons are equally experienced in both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect lack of blinding of assessors of objective measures (mortality) to influence outcome data

Kuokkanen 1991 *(Continued)*

Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were balanced between groups, and due to death, which was expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Lagerby 1998

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus screw
Participants	**Total number of randomised participants/cases:** 285 participants/287 cases **Inclusion criteria:** femoral neck fractures which were undisplaced or displaced **Exclusion criteria:** pathological fractures **Setting:** single centre; hospital; Sweden **Baseline characteristics** **Intervention group 1** (Richards screw) • Age, median (we assumed range): 80 (50 to 94) years • Gender, M/F: 44/86 • Mobility assessment/use of walking aides - 1 cane or none, n: 83; 2 canes or more aids, n: 44; not ambulatory, n: 1 • Place of residence - living in an institution, n: 41 • Fracture classification, undisplaced/displaced - Garden's I and II, n: 37; Garden's III and IV, n: 93 **Intervention group 2** (Uppsala screw) • Age, median (we assumed range): 81 (31 to 99) years • Gender, M/F: 45/93 • Mobility assessment/use of walking aides - 1 cane or none, n: 88; 2 canes or more aids, n: 44; not ambulatory, n: 5 • Place of residence - living in an institution, n: 47 • Fracture classification, undisplaced/displaced - Garden's I and II, n: 38; Garden's III and IV, n: 100 **Notes:** • study authors did not report the following baseline characteristics: smoking history, medication, BMI, comorbidities, cognitive status, ASA status, preoperative waiting time

Lagerby 1998 *(Continued)*

	• study authors report "Radiographic evaluation revealed a higher frequency of posterior cortical support in the Richards group (P = 0.005); otherwise there were no significant differences between the 2 groups, including the occurrence of a small proximal fragment (P = 0.03.)"
Interventions	**General details:** skin traction before surgery for displaced fractures. Operations performed on an extension table with fluoroscopy by 20 surgeons (experience was not reported). Full weight bearing was encouraged from POD1 **Intervention group 1** • 3 Richards cannulated hip screws • Randomised = not specified at group level **Intervention group 2** • 2 Uppsala screws • Randomised = not specified at group level **Notes:** • study authors did not report the following intervention details: type of anaesthetic, prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes reported/measured by study authors:** mortality (reported as overall data, not by group); complications (early re-displacement, screw penetration, non-union, segmental collapse); re-operation, deep infections; use of walking aids; walking or passive joint motion pain **Outcomes relevant to the review:** unplanned return to theatre (re-operation) **Note:** • data for mortality were not reported by group • unplanned return to theatre: reasons for re-operation were deep infection; types of re-operation were replacement with arthroplasty or removal of fixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** May 1992 to April 1994 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Lim 2020

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: short stem versus standard stem
Participants	**Total number of randomised participants:** 151 (study authors report numbers of participants and numbers of hips inconsistently throughout the paper. Because the baseline data is reported for 151 participants, we have used this number as the total number randomised **Inclusion criteria:** people ≥ 65 years of age; femoral neck fractures (Garden's type III or IV) **Exclusion criteria:** history of hip surgery; pathologic fracture; immunologic disorders such as rheumatoid arthritis, avascular necrosis of the femur head; Legg–Calvé–Perthes disease

Lim 2020 *(Continued)*

Setting: single site; orthopaedics department; South Korea

Intervention group 1 (short stem)

- Age, mean (± SD): 81.2 (± 5.6) years
- Gender, M/F, n: 18/59
- BMI, mean (SD): 22.7 (± 3.7) kg/m^2
- ASA status, II/III/IV, n: 7/62/8
- Preoperative mobility, Koval's 1/2/3/4/5/6/7, n: 41/15/2/5/12/2/0
- Garden's type, III/IV, n: 13/63

Intervention group 2 (standard)

- Age, mean (± SD): 80.8 (± 6.4) years
- Gender, M/F, n: 17/57
- BMI, mean (SD): 22.0 (± 3.1) kg/m^2
- ASA status, II/III/IV, n: 5/59/10
- Preoperative mobility, Koval's 1/2/3/4/5/6/7, n: 43/8/5/4/8/6/0
- Garden's type, III/IV, n: 16/58

Note:

- study authors did not report: medication; place of residence; preoperative waiting time; comorbidities; mobility

Interventions	**General details:** all cementless; 5 mg of zoledronate intravenously annually and calcium and vitamin D supplements orally; posterolateral approach - single experienced hip surgeon; immediate weight bearing; both bipolar; clinical follow-up at 6 weeks, 3, 6, 9, and 12 months, and every year thereafter **Intervention group 1** • HA short stem; Bencox M stem (Corentec, Cheonan-si, South Korea); proximal Ti-plasma spray microporous coating; length 95–119 mm • Randomised = 77 hips **Intervention group 2** • HA standard; Bencox ID stem (Corentec, Cheonan-si, South Korea); proximal Ti-plasma spray porous-coated standard metaphyseal fixation; length 137–177 mm • Randomised = 74 hips
Outcomes	**Outcomes measured/reported by study authors:** activity level (Koval's categories); thigh pain; stability of the femoral stem; fixation status; stress shielding grade; leg-length discrepancy; heterotopic ossification; BMD **Outcomes relevant to the review:** mortality
Notes	**Funding/sponsor/declarations of interest:** study authors received no funding and declared no conflicts of interest **Study dates:** not reported **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Lindequist 1989

Study characteristics	
Methods	Quasi-randomised; consecutive series design **Review comparison group:** screw (von Bahr) or screw (Guoffon) versus smooth pin Note: • participants were allocated to von Bahr screw or Hessel pins in 1983 and 1984, and with von Bahr screws or Guoffon screws in 1984 and 1985
Participants	**Total number of randomised participants:** 220 **Inclusion criteria:** people with femoral neck fractures **Exclusion criteria:** pathological fractures **Setting:** single centre; hospital; Sweden **Baseline characteristics (overall)** • Age, mean (range): male 76 (40 to 94) years; female 78 (32 to 97) years • Gender, M/F: 64/156 • Place of residence: 130 home; 39 geriatric wards; 45 old people's homes • Preoperative waiting time, mean (SD): aimed to operate within 2 days **Note:** • study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, BMI, mobility assessment, cognitive status, displacement
Interventions	**General details:** 13 surgeons; extension table, displaced fractures reduced by closed methods, compression not routinely performed; spinal anaesthetic; thrombosis prophylaxis, no prophylactic antibiotics; mobilised and encouraged full weight bearing **Intervention group 1** • von Bahr screws • Randomised =108 **Intervention group 2** • Gouffon screws • Randomised = 65 **Intervention group 3** • Hessel pins • Randomised = 47
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 12 and 24 months); non-union; segmental collapse; re-operation; follow-up at 1 and 2 years **Outcomes relevant to the review:** mortality (12 months); unplanned return to theatre **Notes:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were removal of fixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** 1983 to 1985

Lindequist 1989 *(Continued)*

Note:

- we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Liu 2017

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** internal fixation vs HA
Participants	**Total number of randomised participants:** 153 **Inclusion criteria:** people ≥ 65 years of age; displaced femoral neck fracture, presenting with angular displacement in each radiographic pane and CT scan; low-energy fracture; delay of < 72 hours from injury to hospitalisation **Exclusion criteria:** bedridden; had concomitant hip disease; had sustained a hip fracture in the last two years; had an old or pathological fracture; diagnosed as having cognitive impairment, could not follow the physician's instructions, or refused to participate in the study **Setting:** single-centre; hospital; China **Baseline characteristics** **Intervention group 1** (internal fixation) • Age, mean (SD): 72.6 (± 7.2) years • Gender, M/F: 29/48 • BMI, mean (SD): 23.2 (± 3) kg/m^2 • Comorbidities (type not described), n: 36 • Mobility assessment, walking without aids, n: 48 • Preoperative waiting time, mean (SD): 25.8 (± 24) hours **Intervention group 2** (HA) • Age, mean (SD): 75.9 (± 6.6) years • Gender, M/F: 31/45 • BMI, mean (SD): 22.7 (± 3.0) kg/m^2 • Comorbidities (type not described), n: 44 • Mobility assessment, walking without aids, n: 52 • Preoperative waiting time, mean (SD): 30.7 (± 27.4) hours **Overall** • Place of residence, own home/nursing home: 139/3 **Note:** • study authors do not describe baseline characteristics for smoking history, medication, place of residence, cognitive status, ASA status
Interventions	**General details:** ultrasonography of lower extremity and injection of low-molecular-weight heparin; phlebography of lower extremity before surgery; epidural anaesthesia; early mobilisation with weight bearing **Intervention group 1**

Liu 2017 *(Continued)*

- IF; closed reduction; 3 parallel cannulated screws (DePuy Synthes)
- number randomised = 77; losses = 7 (dropped out); analysed = 70

Intervention group 2

- HA; Charnley-Hastings bipolar cemented prosthesis (Zimmer)
- number randomised = 76; losses = 4 (dropped out); analysed = 72

Note:

- study authors did not report number of surgeons (or skills and experience of surgeons) or the use of prophylactic antibiotics

Outcomes	**Outcomes measured/reported by study authors:** cost; re-operation (with reasons); osteoporotic fracture; rehospitalisation due to fracture; mortality (available during hospitalisation, and at 2 years); rehabilitation **Outcomes relevant to the review:** mortality (during hospitalisation); unplanned return to theatre (24 months) **Note:** • we did not include data for mortality at 24 months because this was reported as an overall number rather than by group
Notes	**Funding/sponsorship/declarations of interest:** funding not reported. Study authors declared no conflicts of interest **Study dates:** May 2013 to September 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "by choosing sealed envelope [sic]"
Allocation concealment (selection bias)	Unclear risk	Sealed envelopes; study authors do not report whether envelopes are sequentially numbered or opaque
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind participants to intervention groups. However, we did not expect that this would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors do not report the number of surgeons or their skills or experience with both types of interventions
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was relatively few (11 participants dropped out), was well-reported and reasonably balanced between groups
Other bias	Low risk	We identified no other sources of bias

Liu 2017 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trial registration or prepublished protocol. It is not feasible to effectively assess risk of reporting bias without these documents

Livesley 1993

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** HA: uncemented (Furlong HAC) versus uncemented
Participants	**Total number of randomised participants:** 82 **Inclusion criteria:** displaced subcapital fracture of the femur; walking normally before surgery **Exclusion criteria:** none reported **Setting:** single site; general hospital; UK **Intervention group 1** (HAC) • Age, mean (± SD): 81.3 (± 7.8) years • Preoperative waiting time mean (± SD): 3.8 (± 4.5) days • Place of residence, home/sheltered housing/nursing home/hospital, n: 34/4/7/2 **Intervention group 2** (uncemented) • Age, mean (± SD): 80 (± 8.3) years • Preoperative waiting time mean (± SD): 2.5 (± 1.6) days • Place of residence, home/sheltered housing/nursing home/hospital, n: 20/6/8/0 **Note:** • study authors did not report: gender, medication; BMI; comorbidities; ASA status; mobility
Interventions	**General details:** "several surgeons", postoperative management the same in both groups (details not specified) **Intervention group 1** • HA uncemented; HAC bipolar hemiarthroplasty (Joint Replacement Instrument Ltd) • Randomised = 48; analysed = 48 **Intervention group 2** • HA uncemented; press-fit Moore-bipolar (DePuy-Thackray) • Randomised = 34; analysed = 34
Outcomes	**Outcomes measured/reported by study authors:** hip function assessment; mortality; discharge destination; adverse events: perioperative fractures, dislocation, wound infection, revision (for infection, anterior thigh pain, or fracture blow prosthesis); foot drop; pressure sores; perioperative complications (calcar splits, shaft fracture, greater trochanteric detachment, lesser trochanter detachment, prosthesis placed in internal rotation) **Outcomes relevant to the review:** mortality (at 30 days, and 1 year); unplanned return to theatre (revision) **Notes:**

Livesley 1993 *(Continued)*

- unplanned return to theatre: reasons for re-operation were infection, periprosthetic fracture and pain; types of re-operation were not reported

Notes	**Funding/sponsor/declarations of interest:** no commercial funding **Study dates:** October 1989 to September 1990

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Allocated by week of admission
Allocation concealment (selection bias)	High risk	It is not feasible to conceal allocation because selection was made according to week of admission
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population. Data for all outcomes were complete
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Lu 2017

Study characteristics

Methods	RCT; parallel design **Review comparison group:** internal fixation vs HA
Participants	**Total number of randomised participants:** 78

Lu 2017 *(Continued)*

Inclusion criteria: people with undisplaced femoral neck fractures; > 80 years of age; capable of walking independently or with aids before injury; no serious cognitive impairment; ASA I to III; time of injury to surgery ≤ 72 hours

Exclusion criteria: pathological fractures; pain in the hip before injury; refusal to participate in study

Setting: multicentre; 2 hospitals; China

Baseline characteristics

Intervention group 1 (internal fixation)

- Age, mean (SD): 85.85 (± 3.93) years
- Gender, M/F: 12/29
- BMI, mean (SD): 26.58 (± 6.10) kg/m^2
- Comorbidities, type, n:
  - Hypertension: 6
  - Diabetes: 4
  - IHD: 3
  - COAD: 2
  - Cerebral infarction: 1
  - Renal inadequacy: 0
  - Hypertension and diabetes: 5
  - Hypertension and IHD: 3
  - IHD and COAD: 2
  - Hypertension and COAD: 2
  - Hypertension and CI: 2
  - Hypertension and diabetes and IHD: 1
- Mobility assessment/use of walking aids:
  - none: 19
  - stick: 16
  - walking frame: 6
- ASA status, I/II/III: 11/18/13
- Preoperative waiting time, n:
  - < 6 hours: 5
  - 6 to 12 hours: 12
  - 12 to 24 hours: 11
  - 24 to 48 hours: 8
  - 48 to 72 hours: 5
- Fracture classification, Garden's I/II, n: 20/21

Intervention group 2 (HA)

- Age, mean (SD): 86.24 (± 4.72) years
- Gender, M/F: 8/29
- BMI, mean (SD): 26.62 (± 5.7) kg/m^2

Lu 2017 *(Continued)*

- Comorbidities, type, n:
  - Hypertension: 9
  - Diabetes: 3
  - IHD: 2
  - COAD: 4
  - Cerebral infarction: 0
  - Renal inadequacy: 1
  - Hypertension and diabetes: 4
  - Hypertension and IHD: 2
  - IHD and COAD: 1
  - Hypertension and COAD: 2
  - Hypertension and CI: 0
  - Hypertension and diabetes and IHD: 1
- Mobility assessment/use of walking aids:
  - none: 20
  - stick: 13
  - walking frame: 4
- ASA status, I/II/III: 8/14/15
- Preoperative waiting time, n:
  - < 6 hours: 5
  - 6 to 12 hours: 8
  - 12 to 24 hours: 9
  - 24 to 48 hours: 10
  - 48 to 72 hours: 5
- Fracture classification, Garden's I/II, n: 18/19

Notes:

- study authors did not report baseline characteristics for smoking history, medication, place of residence, and cognitive status

Interventions	**General details:** completed by 2 groups of well-experienced expert surgeons, using standard operative practices, under general anaesthesia; IV infusion of antibiotics for 3 days, and injection of low-molecular-weight heparin as thomboembolic prophylactic for 10 days after the operation **Intervention group 1:** • IF; 3 cannulated AO 6.5 mm screws • number randomised = 41, losses = 1 (lost to follow-up); analysed = 41 **Intervention group 2:** • HA; using modified Hardinge approach; cemented Exeter stem (Smith & Nephew Medical Ltd, UK) with bipolar head (Smith & Nephew Medical Ltd, UK) with 28 mm diameter inner head in all cases; use of third-generation cementing techniques • number randomised = 37, losses = 2 (lost to follow-up); analysed = 37 **Note:** • study authors do not report details of mobilisation and weight bearing
Outcomes	**Outcomes measured/reported by study authors:** length of incision; duration of operation; blood loss; haemoglobin drop; blood transfusion; length of hospital stay; re-operations (and reasons); functional status (HHS); complications (dislocation; loosening; displacement; non-union; AVN; symptomatic prominence of screws); mortality (survival curves) **Outcomes relevant to the review:** mortality; unplanned return to theatre (average follow-up time was 38.68 months)

Lu 2017 *(Continued)*

	Note: • we did not include data for mortality because the data were reported in figures as survival curves, and we could not reliably extract numerical data from these figures
Notes	**Funding/sponsorship/declarations of interest:** funding not reported. Study authors declared no conflicts of interest **Study dates:** January 2008 to December 2010

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random numbers
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to intervention groups. However, we did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Low risk	Surgeons were well-experienced and we assumed that this experience was equivalent for both interventions
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few participants lost to follow-up, and these losses were balanced between groups
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trial registration or prepublished protocol. It is not feasible to effectively assess risk of reporting bias without these documents

Lykke 2003

Study characteristics

Methods	RCT; parallel design **Review comparison group:** screw versus smooth pin
Participants	**Total number of randomised participants:** 278 **Inclusion criteria:** people with a unilateral fracture of the femoral neck **Exclusion criteria:** not clearly described. However, numbers of excluded participants were reported for the following: pathological fracture, combined cervical and trochanteric fracture, medial neck frac-

Lykke 2003 *(Continued)*

ture during the healing period of a previous fracture; irreducible fractures treated with hemiarthroplasty

Setting: single centre; hospital; Norway

Baseline characteristics

Intervention group 1 (Ullevaal hip screw)

- Age, mean (range): 81 (56 to 96) years
- Gender, M/F: 24/107
- Mobility assessment: no walking aid: 96; walking aid: 31; confined to bed: 1; unknown: 3
- Place of residence: own home: 72; nursing home: 39; other: 20
- Fracture classification, undisplaced/displaced: 92/39

Intervention group 2 (Hansson hook pins)

- Age, mean (range): 82 (27 to 101) years
- Gender, M/F: 24/123
- Mobility assessment: no aid: 107; walking aid: 34, confined to bed 2; unknown 3
- Place of residence: own home: 98; nursing home: 37; other: 12
- Fracture classification, intracapsular - undisplaced/displaced: 108/39

Overall

- Preoperative waiting time, mean (range): 22 (2 to 72) hours

Note:

- study authors did not report any baseline data for: smoking history, BMI, cognitive status; the preoperative waiting time is reported for both groups

Interventions	**General details:** 39 surgeons: residents (number of procedures in study = 197); orthopaedic surgeons (64); accredited general surgeons (17). All completed three procedures before joining study. Antibiotics and thromboembolic prophylaxis given. Closed reduction of displaced fractures. Spinal anaesthetic management. Immediate mobilisation, and encouraged to bear weight (excluding healthier, young participants, who had only partial weight bearing for first 12 weeks); clinical and radiological follow-ups at 4, 12 and 24 months **Intervention group 1** • Ulleval hip screw (Orthovita, Norway) shaft and wing diameter 7.0 mm, core diameter 5.0 mm. Two distal screws, one anteroposterior • Randomised = 131; unclear number lost to follow-up (and we did not include outcome data affected by this); analysed = 131 **Intervention group 1** • Hansson hook-pin (Swemac, Linköping, Sweden), cannulated blunt pin (nail), diameter 6.5 mm, two pins placed • Randomised = 147; unclear number lost to follow-up (and we did not include outcome data affected by this); analysed = 147
Outcomes	**Outcomes measured/reported by study authors:** duration of surgery; fracture reduction; positioning of device; drill penetration; DVT; pneumonia; haematoma; superficial infection; number of early fixation failures (requiring re-operation); non-union (requiring re-operation); segmental collapses (requiring re-operation); mortality (available in hospital; at 4 months; at 2 years); length of hospital stay; place of discharge; return to previous living conditions; need for subsequent arthroplasty after drill penetration and according to implant positioning; pain when walking; impaired walking ability **Outcomes relevant to the review:** unplanned return to theatre, mortality (4 and 24 months)

Lykke 2003 *(Continued)*

	Notes: • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** April 1997 to December 1998

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No detail on how randomisation of envelopes were prepared
Allocation concealment (selection bias)	Low risk	Use of numbered, sealed, opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	All surgeons had completed three procedures with the implants before beginning the study, and we judged this to mean that they were equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors did not report numbers lost to follow-up and we therefore could not include data for some outcomes. However, for remaining outcomes, data were complete
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Clinical trial registration or prepublished protocol not reported. It is not feasible to effectively assess risk of selective reporting bias without these documents

Macaulay 2008

Study characteristics

Methods	RCT; parallel design **Review comparison group:** THA versus HA
Participants	**Total number of randomised participants:** 41

Macaulay 2008 *(Continued)*

Inclusion criteria: > 50 years of age; independent ambulation before fracture; displaced femoral neck fracture (Garden's III or IV which the surgeon considered not amenable to treatment with internal fixation); ability to comprehend and read either English or Spanish
Exclusion criteria: chronic severe dementia (defined as < 23 out of 30 on Folstein MMSE); pathologic fracture; other concomitant long bone fractures or fractures requiring surgical repair; pre-existing arthritis of the hip

Setting: five sites; medical centres; USA

Intervention group 1 (THA; baseline data missing for 1 participant)

- Age, mean (± SD): 82 (± 7) years
- Gender, M/F, n: 10/7
- Comorbidities, average number (range): 3.5 (0 to 7)
- Ethnicity, n:
  - White: 16
  - Black or African–American: 0
  - Hispanic: 1

Intervention group 2 (HA)

- Age, mean (± SD): 77 (± 9) years
- Gender, M/F: 9/14
- Comorbidities, average number (range): 4.2 (1-11)
- Ethnicity, n:
  - White: 19
  - Black or African–American: 1
  - Hispanic: 1

Note:

- study authors did not report: medication; BMI; preoperative waiting time; ASA status; mobility

Interventions	**General details:** surgeon choice: posterior (posterolateral) approach with enhanced soft tissue repair or direct lateral (modified Hardinge) approach **Intervention group 1** • THA; employment of a prosthetic head was ≥ 28 mm; surgeon's preference for cemented/uncemented • Randomised = 18 **Intervention group 2** • HA; surgeon's preference for cemented/uncemented and unipolar/ bipolar prosthesis • Randomised = 23
Outcomes	**Outcomes measured/reported by study authors:** function (WOMAC and HHS; data available at 12 and 24 months); HRQoL (SF-36; data available at 12 and 24 months); functional tasks; HHS (data available at 12 and 24 months); mobility (TUG; data available at 12 and 24 months); complications: additional hospitalisations, care utilisation, re-operations, ambulatory status; length of stay in hospital; mortality (6 months and 34 months) **Outcomes relevant to the review:** mortality (at 6 months, and 34 months); HRQoL (SF-36 physical components)
Notes	**Funding/sponsor/declarations of interest:** partial or total financial support from: American Assoication of Hip and Knee Surgeons and Orthopaedic Research and Education Foundation grants **Study dates:** not reported **Note:**

Macaulay 2008 *(Continued)*

- we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Madsen 1987

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Total number of randomised participants:** 104 **Inclusion criteria:** displaced only **Exclusion criteria:** Garden's I and II fractures; pathological fractures **Setting:** hospital; single centre; Denmark **Baseline characteristics** **Intervention group 1** (AO screw) • Age, mean (range): 74 (34 to 92) • Gender, M/F: 11/41 • Fracture classification, intracapsular - undisplaced/displaced: Garden's III = 33; IV = 19 **Intervention group 2** (sliding hip screw) • Age, mean (range): 75 (25 to 91) years • Gender, M/F: 14/37 • Fracture classification, undisplaced/displaced: Garden's III = 37; Garden's IV = 14 **Note:** • operated within 24 hours of arrival at the fracture department • study authors did not report baseline characteristics overall, nor did they report any baseline data for: smoking history, BMI, mobility assessment, place of residence, cognitive status
Interventions	**General details:** same team of clinicians for all operations; traction applied to all participants; closed reduction performed; early weight bearing; prophylactic antibiotics were not used **Intervention group 1** • ASIF - 4 cancellous bone screw, Linde 1986 describes them as AO screws • Randomised = 52; analysed = 51 **Intervention group 2** • Sliding Screw Plate; • Randomised = 51; analysed = 51 **Note:** • 17 lost to follow-up over both groups (described in an associated publication, Linde 1986): 1 died before operation; 7 died before assessment; 5 moved away; 4 too frail to attend (although this information does not match the numbers reported for each group above)
Outcomes	**Outcomes measured/reported by study authors:** union; non-union; blood loss; duration of anaesthesia; device removed; hip arthroplasty; late segmental collapse; deep infection

Madsen 1987 *(Continued)*

	Outcomes relevant to the review: unplanned return to theatre (we used data for device removal and hip arthroplasty) **Note:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty or removal of fixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not described
Allocation concealment (selection bias)	Unclear risk	Randomisation procedure and concealment not clearly described
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Although the same surgeons were used in all procedures, study authors do not report whether the surgeons were equally experienced with both types of implants
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Data were complete for non-union and unplanned return to theatre. But we noted a large dropout up to 24 months which was not explained in text, and with more loss in the fixed angle plate group. This affected data for AVN and we judged risk of attrition bias to be high for this outcome
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Malhotra 1995

Study characteristics

Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar
Participants	**Total number of randomised participants:** 68 **Inclusion criteria:** elderly people with femoral neck fractures

Malhotra 1995 *(Continued)*

	Exclusion criteria: none reported **Setting:** single site; general hospital; India **Intervention group 1** (bipolar) • Age, mean: 65 years • Gender, M/F, n: 18/14 **Intervention group 2** (unipolar) • Age, mean: 68 years • Gender, M/F, n: 20/12 **Note:** • study authors did not report: medication; BMI; comorbidities; preoperative waiting time; ASA status; mobility
Interventions	**General details:** Moore's posterior approach for both groups; no cement fixation; antibiotic prophylaxis (10 days); prophylactic anticoagulation not routinely used; weight bearing after 3 days; clinical follow-up at 6 weeks, 6 months, and then annually **Intervention group 1** • HA bipolar; indigenously made Bateman-type bipolar prosthesis • Randomised = 32 **Intervention group 2** • HA unipolar, Austin-Moore • Randomised = 36
Outcomes	**Outcomes measured/reported by study authors:** "results of surgery"; loosening; angular shift; settling; deep infection; dislocation; acetabular erosion; subsidence; mobility; length of stay in hospital; functional status (using Devas 1983) **Outcomes relevant to the review:** none
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** commenced January 1989; 4 year period **Note:** • we did not complete risk of bias assessment because this study reported no relevant review outcomes

Mattsson 2003

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus screw
Participants	**Total number of randomised participants:** 40 **Inclusion criteria:** people with a displaced femoral neck fracture, caused by a low-energy trauma when falling on the same level; signed informed consent; ambulatory without walking aid or with 1 cane prior to injury; normal contralateral hip

Mattsson 2003 *(Continued)*

Exclusion criteria: senility; pathological fracture; concurrent fracture that would affect postoperative weight bearing

Setting: single centre; university hospital; Sweden

Baseline characteristics

Intervention group 1 (screws augmented with cement)

- Age, mean: 77.9 years
- Gender, 2/18
- Mobility assessment/use of walking aides: all were walking with ≤ 1 cane prior to injury
- Fracture classification, undisplaced/displaced: all displaced

Intervention group 2 (2 screws without augmentation)

- Age, mean: 78 years
- Gender, M/F: 5/15
- Mobility assessment/use of walking aides: all were walking with ≤ 1 cane prior to injury
- Fracture classification, undisplaced/displaced: all displaced

Notes:

- study authors did not report the following baseline characteristics: smoking history, medication, BMI, comorbidities, place of residence, cognitive status, ASA status, preoperative waiting time

Interventions	**General details:** most operation done within 24 hours following the trauma; performed under spinal anaesthesia; closed reduction on a traction table; unrestricted weight bearing after radiostereometric analysis (within 24 hours) **Intervention group 1** • 2 cannulated screws combined with calcium-phosphate cement • Randomised = 20 **Intervention group 2** • 2 Uppsala screws • Randomised = 20 **Notes:** • study authors did not report the following intervention details: number of surgeons (and their skills or experience); use of prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** wound infections; maximal total point motion (MTPM); angulation **Outcomes relevant to the review:** none
Notes	**Funding/sponsor/declarations of interest:** cement used in the augmentation of the comparative screw was supplied by Norian SRS for this study **Study dates:** not reported **Note:** • we did not complete risk of bias assessment because this study reported no relevant review outcomes

Mattsson 2006

Study characteristics	
Methods	RCT; single centre; parallel design **Review comparison group:** screw versus screw
Participants	**Total number of randomised participants:** 118 **Inclusion criteria:** displaced femoral neck fracture (Garden's III to IV); > 60 years of age; surgery within 72 hours of admission; normal contralateral hip **Exclusion criteria:** senility, earlier hip surgery, soft tissue infection at operative site, ongoing radiotherapy or chemotherapy due to malignancy, pathological fracture, clotting disorder, corticosteroid treatment exceeding 5 mg per day, concurrent fracture, serious concomitant illness or mental instability, neurosensory, neuromuscular or musculoskeletal deficiency **Setting:** single centre; hospital; Sweden **Baseline characteristics (overall)** • Age: range 60 to 98 years • Gender, M/F: 23/95 • Preoperative waiting time: < 72 hours • Fracture classification: 100% displaced - closed reduction
Interventions	**General details:** 2 surgeons; closed reduction and internal fixation with cannulated screws; traction table with image intensifier lateral approach; spinal anaesthetic **Intervention group 1** • Screws with calcium phosphate augmentation - cement was injected in the two screw canals and the screws were inserted while the cement was still soft (Norian Corp., Cupertino, CA) • Randomised = 58 **Intervention group 2** • 2 self-tapping cannulated screws - screws only: lateral cortex was drilled and two self-tapping cannulated screws inserted (Olmed AB, Uppsala, Sweden) • Randomised = 60
Outcomes	**Outcomes measured/reported by study authors:** unplanned return to theatre; pain (VAS); activities of daily living; mobility (D'Aubigne); at 1 and 6 weeks; 6, 12 and 24 months **Outcomes relevant to the review:** unplanned return to theatre (24 months); mortality (6 weeks and 12 months) **Notes:** • unplanned return to theatre: reasons for re-operation were deep infection, segmental collapse, non-union or loss of reduction; types of re-operation not reported
Notes	**Funding/sponsor/declarations of interest:** Trygg-Hansa; Statec Medical AB for implant costs **Study dates:** not reported **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Mjørud 2006

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus smooth pin
Participants	**Total number of randomised participants:** 199 **Inclusion criteria:** all admitted with cervical hip fracture **Exclusion criteria:** non-healed contralateral hip fracture; pathological fracture; extracapsular extension; rheumatoid arthritis **Setting:** hospital; single centre; Norway **Baseline characteristics** **Intervention group 1** (AO screws) • Age, mean (SD): 81 (± 12) years; range 28-101 • Gender, M/F: 24/77 • Mobility assessment/use of walking aides: no aid 77; with aid 14; not walking; 5; unknown 4 • Place of residence: own home 66; nursing home 24; other 10 • Preoperative waiting time, mean (SD): 28 (± 55) hours • Fracture classification, intracapsular - undisplaced/displaced: 30/71 • Additional information: high-energy trauma, n: 2 **Intervention group 2** (Hook-pins) • Age, mean (SD): 81(± 11) years • Gender, M/F: 22/76 • Mobility assessment/use of walking aides: no aid 75; with aid 17; not walking; 4; unknown 4 • Place of residence: 64; nursing home 25; other 11 • Preoperative waiting time, mean (SD): 28 (± 54) hours • Fracture classification, intracapsular - undisplaced/displaced: 40/58 • Additional information: high-energy trauma, n: 3 **Note:** • study authors did not report overall characteristics nor did they report baseline data for: smoking history, medication, BMI, comorbidities, cognitive status/dementia, fracture classification
Interventions	**General details:** 22 surgeons - registrar (73% overall), specialist orthopaedic surgeon (26%), specialist general surgeon (1%); no difference between groups; prophylactic antibiotics were rarely used; thrombosis prophylaxis were used for all patients; immediate weight bearing (except for some under 50 years of age) **Intervention group 1** • 3 AO titanium screws • Randomised = 101; numbers lost to follow-up not clearly reported (and we did not include outcome data affected by this); analysed = 101 **Intervention group 2** • 2 Hansson hook pins • Randomised = 98; numbers lost to follow-up not clearly reported (and we did not include outcome data affected by this); analysed = 98 **Note:**

Mjørud 2006 *(Continued)*

- preoperative care; anaesthetic management; rehabilitation not reported

Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 4 months, 12 months and 24 months); re-operation, reasons given: changed position, displacement, pseudarthrosis, femoral head-necrosis, local tenderness; discharge destination (only provided for overall group); mobility (only reported for overall group, or in a figure from which we could not confidently extract exact data) **Outcomes relevant to the review:** mortality (at 4 months and 12 months); unplanned return to theatre (24 months) **Note:** • unclear on the number assessed at one- and two-year follow-ups, no dropout reported apart from death • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty, removal of fixation or resection of the femoral head
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** May 1997 to March 1999

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation methods described: "Randomisation was performed in blocks of 50 with sealed numbered envelopes to ensure a consecutive randomisation"
Allocation concealment (selection bias)	Low risk	Sealed, numbered envelopes were used
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Although the numbers and level of surgical experience were similar between groups, study authors do not report whether surgeons were equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors did not report numbers lost to follow-up and we therefore could not include data for some outcomes. However, for remaining outcomes, data were complete
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Moerman 2017

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented

Participants	**Total number of randomised participants:** 201
	
	Inclusion criteria: ≥ 70 years of age; displaced femoral neck fracture (Garden's type III or IV)
	Exclusion criteria: pathological fracture, a fracture > 7 days, or ASA IV or V
	
	Setting: 5 medical centres; USA
	
	Intervention group 1 (cemented; some characteristics not reported for all participants)
	
	• Age, mean (SD): 83.0 (± 6.2) years
	• Gender, M/F, n: 28/82
	• BMI, mean (SD): 24.1 (± 3.4) kg/m^2
	• Mobility assessment/use of walking aides:
	  ○ mobile without aid indoors (n/total): 41 out of 81
	  ○ mobile without aid outdoors (n/total): 32 out of 81
	  ○ NMS, mean (SD): 5.5 (± 3.0)
	• Place of residence, living at home, n/total: 58/84
	• Cognitive status, MMSE score < 24, n/total: 23/56
	• ASA status, I/II/III, n: 6/71/33
	• Additional information:
	  ○ GARS, mean (SD): 41.7 (± 18.6)
	
	Intervention group 2 (uncemented; some characteristics not reported for all participants)
	
	• Age, mean (SD): 84.0 (± 6.7) years
	• Gender, M/F, n: 30/61
	• BMI, mean (SD): 24.3 (± 3.5) kg/m^2
	• Mobility assessment/use of walking aides:
	  ○ mobile without aid indoors (n/total): 32/73
	  ○ mobile without aid outdoors (n/total): 21/73
	  ○ NMS, mean (SD): 5.2 (± 2.7)
	• Place of residence, living at home, n/total: 52/73
	• Cognitive status, MMSE score < 24, n/total: 15/44
	• ASA status, I/II/III, n: 7/51/33
	• Additional information:
	  ○ GARS, mean (SD): 41.1 (± 16.8)
	
	Note:
	
	• study authors did not report: medication; comorbidities; preoperative waiting time

Interventions	**General details:** orthopaedic surgeon or registrar performed the operation; approach decided by surgeon; physiotherapy; analgesia and thromboembolic prophylaxis; clinical follow-up at 6 weeks, 12 weeks, and 12 months **Intervention group 1** • HA cemented, type Müller Straight Stem (Zimmer - Biomet, Warsaw, USA); cementing technique involved vacuum mixing, cement plug, saline pulsed lavage and retrograde introduction of cement with a cement gun

Moerman 2017 *(Continued)*

- Randomised = 110; reported losses = 57 (21 died at 12 months; 36 lost to follow-up); analysed for HRQoL at 3 months = 54; analysed for HRQoL at 12 months = 50; analysed for other outcomes = 110

Intervention group 2

- HA uncemented, type DB-10 (Zimmer - Biomet, Warsaw, USA)
- Randomised = 91; reported losses = 47 (25 died at 12 months; 22 lost to follow-up); analysed for HRQoL at 3 months = 48; analysed for HRQoL at 12 months = 40; analysed for other outcomes = 91

Outcomes	**Outcomes measured/reported by study authors:** operation time; blood loss; length of stay, decrease in haemoglobin level; transfusion rate; TUG score, GARS, NMS, HRQoL (SF-12 PCS and MCS), mid-thigh pain (reported at 6 weeks, 12 weeks and 1 year); mortality; complications (death, tachyarrhythmia, MI, pulmonary embolism, acute renal failure, stroke and/or TIA, bowel obstruction, anaemia, UTI, mental status change, gastric hypomotility, DVT, pneumonia, social complication, peripheral nerve injury, infection leading to revision, periprosthetic fracture (intra- and postoperatively), dislocation, haematoma, persistent wound drainage, superficial wound infection, skin blisters **Outcomes relevant to the review:** mortality (12 months); HRQoL: SF-12 (physical component; at 12 weeks and 1 year); unplanned return to theatre **Notes:** • unplanned return to theatre: reasons for re-operation were infection and loosening; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** August 2008 and June 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "randomized following a simple randomization procedure in the operation theatre" Comment: insufficient information on methods of randomisation
Allocation concealment (selection bias)	Low risk	Quote: "opaque sealed envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that the interventions were performed by orthopaedic surgeons or registrars but we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Participants blind to intervention
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data
Blinding of outcome assessment (detection bias):	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective

Moerman 2017 *(Continued)*

unplanned return to theatre		
Incomplete outcome data (attrition bias) All outcomes	High risk	We noted a large number of participants lost to follow-up at 12 months, with more lost in the cemented group. We also noted some variation in the number of reported participants for each outcome at each time point which was not explained
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Low risk	Registered with a clinical trials register (NTR1508; first received October 2008). Registration soon after start of trial. All outcomes in the published report are consistent with those in the clinical trials register documents

Moroni 2002

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** mixed HA and THA: uncemented versus cemented
Participants	**Total number of randomised participants:** 28 **Inclusion criteria:** AO/OTA fracture type B2 and B3; female ≥ 75 years of age, fracture resulting from minor trauma, ability to communicate and BMD T-score at the contralateral hip < -2.5 SD **Exclusion criteria:** none reported **Setting:** single centre; hospital; Italy **Intervention group 1** (uncemented) • Age, mean (SD): 75 (± 5) years • Gender, M/F: all female **Intervention group 2** (cemented) • Age, mean (SD): 75 (± 5) years • Gender, M/F: all female **Note:** • study authors did not report: BMI; mobility; medication; smoking history, comorbidities; place of residence, preoperative waiting time
Interventions	**General details:** none reported **Intervention group 1** • AHS prosthesis; cemented; 6 participants underwent unipolar HA and 9 participants underwent THA • Randomised = 15; losses not reported; analysed = 15 **Intervention group 2** • Furlong prosthesis; hydroxyapatite-coated hip arthroplasty; 4 participants underwent unipolar HA and 9 underwent THA • Randomised = 13; losses not reported; analysed = 13
Outcomes	**Outcomes measured/reported by study authors:** HHS; SF-36; mortality; revision (due to loosening)

Moroni 2002 *(Continued)*

Outcomes relevant to the review: mortality; HRQoL (SF-36)

Notes:

- average follow-up was 24 months for intervention group 1 and 22 months for intervention group 2.
- we did not report data for revision (because of loosening) because data were reported only for one group

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported **Note:** • Data are available only in abstracts. We used the data published in the 2002 abstract, rather than a later 2009 abstract. We noted inconsistencies between the two abstracts, and we judged the earlier abstract to be more reliable. • we did not complete risk of bias assessment because both comparison groups in this study included a mix of HA and THA

Motififard 2010

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF vs THA
Participants	**Total number of randomised participants:** 80 **Inclusion criteria:** displaced, transcervical fracture of the proximal femur; able to walk without aids; cognitively intact; aged between 60 and 70 years; treatment given within 24 hours of the injury **Exclusion criteria:** serious cardiorespiratory comorbidity, pathological fracture, rheumatoid arthritis, osteoarthritis **Setting:** secondary care hospital; Iran **Baseline characteristics** **Intervention group 1** (IF) • Age, mean (SD): 66.1 (± 0.75) years • Gender, M/F: 8/32 **Intervention group 2** (THA) • Age, mean (SD): 67.3 (± 0.5) years • Gender, M/F: 14/26 **Note:** • study authors do not report baseline characteristics for: smoking history, medication, BMI, comorbidities, place of residence and ASA status
Interventions	**General details:** treatment given within 24 hours of injury, 40 mg clexane once daily, 1 g perioperatively, and 2 days of 1 g cefazolin, 4 times a day **Intervention group 1**

Motififard 2010 *(Continued)*

	• Multiple expert specialist trauma surgeons, experienced in the management of these fractures, performed fracture reduction and fixation with 3 screws under fluoroscopic guidance • Randomised to group = 40; no apparent losses; analysed = 40 **Intervention group 2:** • Single expert specialist hip arthroplasty surgeon performed THA • Randomised to group = 40; no apparent losses; analysed = 40 **Note:** • study authors do not report details for: type of anaesthesia, pre- and postoperative care (e.g. use of prophylactic antibiotics or antithromboembolics), and rehabilitation (e.g. time to mobilisation or weight bearing)
Outcomes	**Outcomes measured/reported by study authors:** length of operation; estimated blood loss: pain scores (VAS, 1 to 10, direction not specified), HHS, HRQoL (SF-36), complications (all at 3 months, 6, months, and 12 months); unplanned return to theatre (12 months) **Outcomes relevant to the review:** unplanned return to theatre (12 months) **Note:** • we did not report data for HRQoL, which was reported as means per group but without SDs and group sizes. Reported P values were only approximations
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** February 2007 to September 2008

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Patients were divided by chance into two groups...with similar age and gender"
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to interventions. We did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Low risk	Surgeons were experienced with types of interventions used in this study
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors did not report losses, and we assumed in analysis that there were no losses
Other bias	Low risk	We identified no other sources of bias

Motififard 2010 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trial registration or prepublished protocol. It is not feasible to effectively assess risk of reporting bias without these documents

Mouzopoulos 2008

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA versus HA versus IF
Participants	**Total number of randomised participants:** 86 **Inclusion criteria:** displaced subcapital hip fracture (Garden's III or IV) after falling down **Exclusion criteria:** previous hip fracture; history of cancer or Paget's disease; rheumatic arthritis **Setting:** hospital; single centre; Greece **Baseline characteristics** **Intervention group 1** (THA; data only reported for 37 participants) • Age, mean (SD): 73.07 (± 4.93) years • Gender, M/F, n: 9/28 • Mobility assessment, ambulatory, n: 37 • Place of residence, own home/with relatives/nursing home, n: 1/36/0 • Cognitive status, using SPMSQ, mean (SD): 7.9 (± 2.6) • ASA status, mean (SD): 2.03 (± 1.97) • Preoperative waiting time, mean (SD): 45.2 (± 7.3) hours **Intervention group 2** (HA; data only reported for 34 participants) • Age, mean (SD): 74.24 (± 3.77) years • Gender, M/F, n: 10/24 • Mobility assessment, ambulatory, n: 34 • Place of residence, own home/with relatives/nursing home, n: 0/34/0 • Cognitive status, using SPMSQ, mean (SD): 7.5 (± 3.1) • ASA status, mean (SD): 2.21 (± 1.9) • Preoperative waiting time, mean (SD): 45.8 (± 2.4) hours **Intervention group 3** (IF; data only reported for 38 participants) • Age, mean (SD): 75.38 (± 4.62) years • Gender, M/F, n: 12/26 • Mobility assessment, ambulatory, n: 38 • Place of residence, own home/with relatives/nursing home, n: 1/37/0 • Cognitive status, using SPMSQ, mean (SD): 7.8 (± 2.8) • ASA status, mean (SD): 1.96 (± 1.1) • Preoperative waiting time, mean (SD): 44.2 (± 5.2) hours **Note:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities

Mouzopoulos 2008 *(Continued)*

Interventions	**General details:** 2 orthopaedic surgeons; postoperative strengthening exercises and range-of-motion exercises for the hip and knee joint **Intervention group 1** • THA; Plus (De Puy, Warsaw, USA) • Randomised = 43 **Intervention group 2** • HA; Merete (Berlin, Germany) • Randomised = 43 **Intervention group 3** • IF; Richards plate screw (Smith & Nephew, Memphis, USA) • Randomised = 43 **Note:** • study authors did not report the following intervention details: skills and experience of surgeons, type of anaesthesia, use of prophylactic antibiotics or antithromboembolics, time to weight bearing
Outcomes	**Outcomes measured/reported by study authors:** BI (available at 12 months and 4 years); HHS (available at 12 months and 4 years); range of passive hip motion; gait speed; mortality (available at 12 months and 4 years); length of hospital stay; revision **Outcomes relevant to the review:** mortality (at 12 months and 4 years); unplanned return to theatre (revision; at 4 years) **Notes:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** April 1999 to April 2002 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Movrin 2020

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 158 **Inclusion criteria:** ≥ 76 years of age; displaced femoral neck fracture (Garden's III to IV); no concurrent joint disease; no previous hip fractures; intact cognitive functions; ability to ambulate independently with or without walking aids **Exclusion criteria:** Garden's I to II fractures; pathological fractures; rheumatoid arthritis; symptomatic osteoarthritis; deemed unsuitable for surgical procedures by the anaesthesiologist

Movrin 2020 *(Continued)*

Setting: hospital; single centre; Slovenia

Baseline characteristics

Intervention group 1 (cemented)

- Age, mean (SD): 86 (± 5) years
- Gender, M/F, n: 33/46
- ASA status, I-II/III-IV, n: 40/39
- Preoperative HHS, mean (SD): 76.3 (± 17.3)

Intervention group 2 (uncemented)

- Age, mean (SD): 84 (± 4) years
- Gender, M/F, n: 31/48
- ASA status, I-II/III-IV, n: 46/33
- Preoperative HHS, mean (SD): 79.8 (± 19.4)

Note:

- study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities

Interventions	**General details:** 9 consultant or specialist orthopaedic-trauma surgeons performed all operations and were experienced in the use of cemented and uncemented stems; standard anterolateral approach; both implants produced by Ecofit (Implantcast); closed-suction drains were placed in all patients; 2 g tranexamic acid; perioperative antibiotic prophylaxis; low molecular-weight heparin as a thromboembolic prophylaxis; mobilised immediately with weight bearing; initially reviewed after discharge at 6 weeks; subsequent assessments were made at 3, 6, and 12 months **Intervention group 1** • HA cemented; bipolar; 80 mg Palacos cement (Heraeus, Wehrheim, Germany); vacuum mixing, cement plugging, saline pulsed lavage, and retrograde introduction of cement with a cement gun • Randomised = 79; losses = 24 (owing to death at 24 months); analysed = 79 **Intervention group 2** • HA uncemented modular bipolar • Randomised = 79; losses = 27 (owing to death at 24 months); analysed = 79
Outcomes	**Outcomes measured/reported by study authors:** pain (VAS; at 6 weeks and 6 months); intraoperative parameters; bleeding; fracture (intraoperative and postoperative); dislocation; deep infection; mortality (intraoperative, 7 days, 24 months); HHS (6 weeks and 24 months); re-operations **Outcomes relevant to the review:** mortality (7 days and 24 months) **Note:** • we did not report data for revision surgery because it was unclear if these data were reported for both all participants and for groups
Notes	**Funding/sponsorship/declarations of interest:** study received no funding and study authors declared no conflicts of interest **Study dates:** January 2013 and December 2015

Risk of bias

Bias	Authors' judgement	Support for judgement

Movrin 2020 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Method of randomisation not described
Allocation concealment (selection bias)	Low risk	Quote:"randomized using sealed, numbered, and opaque envelopes "
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	Surgeon was experienced with both techniques in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population. We noted loss of 3 participants for HHS data in the uncemented group which was not explained, but we did not expect these few losses to influence outcome data
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Nordkild 1985

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** fixed angle plate versus fixed angle plate
Participants	**Total number of randomised participants:** 49 **Inclusion criteria:** non-pathological fractures of the neck of femur; < 70 years of age or with a high level of physical activity **Exclusion criteria:** > 70 years of age and in poor general condition **Setting:** single centre; hospital; Denmark **Baseline characteristics** **Intervention group 1** (sliding screw plate) • Age, < 60 years, n: 8 • Age, > 60 years, n: 22 • Gender, M/F: 9/21 • Fracture classification, undisplaced/displaced - Garden's I and II, n: 4; Garden's III and IV, n: 23 **Intervention group 2** (sliding nail plate)

Nordkild 1985 *(Continued)*

- Age, < 60 years, n: 12
- Age, > 60 years, n: 7
- Gender, M/F: 7/12
- Fracture classification, undisplaced/displaced - Garden's I and II, n: 2; Garden's III and IV, n: 15 (data not available for 2 participants)

Notes:

- study authors did not report the following baseline characteristics: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, or ASA status

Interventions	**General details:** not performed as an emergency, but was done as soon as possible and no later than 48 hours after admission. Traction applied on admission, final reduction made under general/spinal anaesthesia. Surgery carried out by a "number of surgeons" (exact number not specified, nor their skills or experience) **Intervention group 1** • Sliding screw plate (Howmedica) • Randomised = 30 **Intervention group 2** • Sliding nail plate (Howmedica) • Randomised = 19 **Note:** • study authors did not report the following intervention details: exact number of surgeons, and their skill or experience; use of prophylactic antibiotics or antithromboembolics, postoperative mobilisation regimen
Outcomes	**Outcomes measured/reported by study authors:** reduction of the fracture, position of fixation implant, fixation index, union/non-union, death, redisplacement of the fracture, necrosis, re-operation, complications (not defined), varus, migration of the implant, pain, hip mobility, walking **Outcomes relevant to the review:** unplanned return to theatre (re-operation; median follow-up 40 months (range 1 to 64 months)) **Note:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were removal of fixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** January 1978 to December 1980 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Olerud 1991

Study characteristics	
Methods	RCT; parallel design

Olerud 1991 *(Continued)*

	Review comparison group: screw versus smooth pin
Participants	**Total number of randomised participants:** 115 **Inclusion criteria:** not reported **Exclusion criteria:** not reported **Setting:** single centre; university hospital; Sweden **Baseline characteristics** **Intervention group 1** (Uppsala screw) • Age, mean (SD): 79 (± 10) years • Gender, M/F: 10/49 • Fracture classification, undisplaced/displaced, n: 19/40 **Intervention group 2** (Hansson pin) • Age, mean (SD): 81 (± 9) years • Gender, M/F: 8/48 • Fracture classification, undisplaced/displaced: 14/42 **Notes:** • study authors did not report the following baseline characteristics: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, preoperative waiting time
Interventions	**General details:** surgery performed by 28 different surgeons (experience and skills were not reported); surgery routinely performed the day after admission; fractures reduced on a traction table, and surgery performed under spinal anaesthesia ("with few exceptions"); mobilisation with full weight bearing from POD1 **Intervention group 1** • Uppsala screw • Randomised = 59; losses = 14 (owing to death); analysed = 59 **Intervention group 2** • Hansson pin • Randomised = 56; losses = 8 (owing to death); analysed = 56 **Notes:** • study authors did not report the following intervention details: experience and skills of surgeons; use of prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** pain; mobility; place of residence; complications (penetration of the head, early loosening, non-union, late segmental collapse); mortality **Outcomes relevant to the review:** mortality (12 months)
Notes	**Funding/sponsor/declarations of interest:** quote: although "none of the authors have received or will receive benefits for personal or professional use from a commercial party related directly or indirectly to the subject of this article, benefits have been or will be received but are directed solely to a research fund, foundation, educational institution, or other non-project institution with which one or more of the authors is associated" **Study dates:** June 1987 to June 1988

Olerud 1991 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as a randomised study, but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Although the number of surgeons involved in operations is reported, study authors do not report whether these surgeons are equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	All losses appeared to be owing to death which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration documents. It is not feasible to effectively assess risk of selective reporting bias without these documents

Ovesen 1997

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Total number of randomised participants/cases:** 314 participants/316 cases **Inclusion criteria:** not reported in the abstract; study included participants with displaced and undisplaced fractures **Exclusion criteria:** not reported **Setting:** single centre; university hospital; Denmark **Baseline characteristics (overall)** • fracture classification, undisplaced/displaced, n: 64/252 **Notes:**

Ovesen 1997 *(Continued)*

- study authors did not report baseline characteristics for age, gender, smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, preoperative waiting times

Interventions	**General details:** no details of perioperative surgical management **Intervention group 1** • 2 Uppsala screws • Randomised = 174 participants; 49 losses (reasons for losses are not explained); analysed = 125 (report does not state whether this is number of cases or participants; we have assumed participants) **Intervention group 2** • DHS • Randomised = 142 participants; 39 losses (reasons for losses are not explained); analysed = 103 (report does not state whether this is number of cases or participants; we have assumed participants) **Notes:** • study authors did not report the following intervention details: use of traction to reduce fracture, type of anaesthetic, number of surgeons (and experience or skills), use of prophylactic antibiotics or antithromboembolics, or postoperative mobilisation regimen
Outcomes	**Outcomes measured/reported by study authors:** surgery time; volume of intraoperative blood loss; mortality; healing rate; complication rates (early redisplacement, AVN in a non-united fracture, late segmental collapse, and deep infection); re-operations (excluding removal of implant) **Outcomes relevant to the review:** unplanned return to theatre (re-operation; time point not defined) **Notes:** • study authors reported no data for mortality in the abstract and therefore we could not include this outcome in the review • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were removal of fixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** March 1991 to June 1993 **Note:** • study is published only as an abstract; we therefore have only limited detail for study characteristics and outcome data

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as a prospective randomised study; no additional details of methods used for randomisation
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance

Ovesen 1997 *(Continued)*

Other performance bias: surgeon experience of both implants	Unclear risk	Study authors do not report numbers of surgeons, their level of surgical experience, and whether they were equally experienced with both types of implants
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	High risk	We noted a large number of losses in each group which were not explained
Other bias	High risk	Study report was available only as an abstract which we expected was not peer-reviewed. In addition, because of limited detail in the abstract, we could not be certain of other risks of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Parker 2002

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF versus HA

Participants	**Total number of randomised participants:** 455
	
	Inclusion criteria: > 70 years of age; displaced intracapsular fracture
	
	Exclusion criteria: undisplaced or minimally displaced fractures; age < 71 years; rheumatoid arthritis; chronic renal failure; significant arthritis of the hip; a delay from the fracture to surgery of > 48 hours; fractures secondary to tumour; Paget's disease or metabolic bone disease
	
	Setting: single setting; hospital; UK
	
	Baseline characteristics
	
	Intervention group 1 (IF)
	
	• Age, mean (range): 82.2 (71 to 103) years
	• Gender, M/F: 45/181
	• Comorbidities, type, n: cardiovascular 70; respiratory 24
	• Mobility assessment/use of walking aides: mean mobility score 5.3
	  ◦ no walking aid, n: 139
	  ◦ walking stick, n: 54
	  ◦ frame, n: 31
	  ◦ immobile, n: 2
	• Place of residence, living in own home, n: 151
	• Cognitive status, mental test score, mean: 5.4
	• ASA status, mean: 2.7
	• Preoperative waiting time (injury to surgery), mean: 25.0 hours
	• Fracture classification, displaced, Garden's III/IV, n: 117/109

Parker 2002 *(Continued)*

- Additional information:
  - preoperative haemoglobin (g/L): 128

Intervention group 2 (HA)

- Age, mean (range): 82.4 (71 to 101) years
- Gender, M/F: 46/183
- Comorbidities, type, n: cardiovascular 78; respiratory 23
- Mobility assessment/use of walking aides: mean mobility score 5.2
  - no walking aid, n: 141
  - walking stick, n: 59
  - frame, n: 26
  - immobile, n: 3
- Place of residence, living in own home, n: 164
- Cognitive status, mental test score, mean: 5.5
- ASA status, mean: 2.7
- Preoperative waiting time (injury to surgery), mean: 27.5 hours
- Fracture classification, displaced, Garden's III/IV, n: 113/116
- Additional information:
  - preoperative haemoglobin (g/L): 128

Note:

- authors did not report: smoking history, medication, BMI

Interventions	**General details:** 1 surgeon; perioperative antibiotic cover; thromboembolic prophylaxis with heparin for 5 days; no restrictions on movement of the hip or weight bearing; routine follow-up with annual appointments; spinal anaesthesia in < 405 of participants **Intervention group 1:** • IF; 3 parallel cannulated AO cancellous screws (Stratec Ltd) undertaken percutaneously after closed reduction of the fracture • Randomised = 226; 207 followed correct study protocol; 160 reported as surviving at 1 year, 123 at 2 years, 91 at 3 years; analysed = 226 **Intervention group 2:** • HA; uncemented Austin Moore (Stryker Howmedica Osteonics Ltd, Newbury, UK); anterolateral surgical approach with preservation of the joint capsule • Randomised = 229; 199 followed correct study protocol; 163 reported as surviving at 1 year, 105 at 2 years, 74 at 3 years; analysed = 229
Outcomes	**Outcomes measured/reported by study authors:** pain (Charnley); mobility; residential status; shortening; loss of flexion; mental test score; mortality (all at 12, 24 and 36 months); wound infection; re-operation (at 36 months); length of stay in hospital; postoperative complications **Outcomes relevant to the review:** mortality (at 12 and 36 months, taken from table 3); unplanned return to theatre (described as secondary procedures, at 36 months)
Notes	**Funding/sponsorship/declarations of interest:** authors stated no conflicts of interest **Study dates:** July 1991 to February 2001

Risk of bias

Bias	Authors' judgement	Support for judgement

Parker 2002 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Method of randomisation is not reported
Allocation concealment (selection bias)	Low risk	"Sealed opaque identical envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	One experienced surgeon who we expected was experienced with both techniques in the study
Blinding of outcome assessment (detection bias): mortality	Low risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses mostly explained by death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration documents. It is not feasible to effectively assess risk of selective reporting bias without these documents

Parker 2010c

Study characteristics	
Methods	RCT; single centre; parallel design **Review comparison group:** screw versus screw
Participants	**Total number of randomised participants:** 432 **Inclusion criteria:** people with intracapsular fractures **Exclusion criteria:** not reported **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1 (**short thread: 16 mm) • Age, mean: 76 (range 29 to 96) years • Gender, M/F: 47/163 • Mobility assessment, mean, using Parker scale: 9 = fully mobile, 0 = bed bound: 4.8

Parker 2010c *(Continued)*

- Place of residence: from own home: 168 (80%)
- Cognitive status, mean using MMSE (0 to 10, with 10 being full marks): 6.5
- ASA status, mean: 2.7
- Fracture classification, undisplaced/displaced: 107/103

Intervention group 2 (long thread: 32 mm)

- Age, mean: 77 (range 31 to 99) years
- Gender, M/F: 53/169
- Mobility assessment, mean, using Parker scale: 9 = fully mobile, 0 = bed bound: 5.1
- Place of residence: from own home: 165 (75%)
- Cognitive status, mean using MMSE (0 to 10, with 10 being full marks): 6.0
- ASA status, mean: 2.7
- Fracture classification, undisplaced/displaced: 133/89

Note:

- study authors did not report any baseline data for: smoking history, medication, BMI, comorbidities, preoperative waiting time

Interventions	**General details:** 1 surgeon; reduction completed closed on a fracture table with image intensifier; mobilised full weight bearing, expect those < 60 years **Intervention group 1** • Screws - short threads - 6.5 mm cancellous screws with short threads (16 mm) • Randomised = 210 **Intervention group 2** • Screws - long threads (32 mm) (Stratec Medical, Hertfordshire, UK) • Randomised = 222
Outcomes	**Outcomes measured/reported by study authors:** mortality (12 months); number with residual pain; mean pain score; mean change mobility score; normally used a walking aid; same residence status; non-union; fracture below; AVN; removal; re-operation **Outcomes relevant to the review:** unplanned return to theatre; mortality (12 months) **Note:** • unplanned return to theatre: reasons for re-operation were second fracture, segmental collapse, non-union; types of re-operation were removal of fixation
Notes	**Funding/sponsor/declarations of interest:** no conflicts of interest **Study dates:** April 1996 to July 2005 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Parker 2010d

Study characteristics	
Methods	RCT; parallel design

Parker 2010d *(Continued)*

Review comparison group: HA: cemented versus uncemented

Participants	**Total number of randomised participants:** 400 **Inclusion criteria:** displaced intracapsular fracture, > 60 years of age **Exclusion criteria:** undisplaced or minimally displaced intracapsular fracture; < 60 years of age; 60 to 75 years of age with no restriction in mobility at the time of injury; declined to participate; senile dementia for whom the assent of their next of kin was not obtained; pathological fracture from a tumour or Paget's disease; previous treatment of the same hip for a fracture; not considered to be fit for either of the surgical procedures; significant arthritis of the hip that necessitated treatment with THA; admitted when the lead trialist was not available to supervise the procedure **Setting:** hospital; single centre; UK **Baseline characteristics** **Intervention group 1** (cemented) • Age, mean (range): 83 (61 to 97) years • Gender, M/F, n: 39/161 • Mobility assessment, mobility score, mean: 5.7 • Place of residence, own home, n: 147 • Cognitive status, mental test score, mean: 5.8 • ASA status, mean: 2.7 **Intervention group 2** (uncemented) • Age, mean (range): 83 (62 to 104) years • Gender, M/F, n: 53/147 • Mobility assessment, mobility score, mean: 5.9 • Place of residence, own home, n: 145 • Cognitive status, mental test score, mean: 5.9 • ASA status, mean: 2.7 **Note:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities, preoperative waiting time
Interventions	**General details:** all operations were performed or supervised by 1 orthopaedic surgeon; all received perioperative prophylactic antibiotics and 14 days of low-molecular-weight heparin as thromboembolic prophylaxis; mobilisation as soon as able to, with no restrictions on hip movements or weight bearing; routine follow-up at 6 weeks, then by telephone at 3, 6, 9 and 12 months, then annually up to 5 years **Intervention group 1** • HA cemented; Thompson (Corin Ltd, Cirencester, UK), using Harginge cement restrictor and Palacos bone cement with gentamicin (Schering-Plough Ltd, Welwyn Garden City, UK) • Randomised = 200; losses = 125 (died by end of follow-up); analysed = 200 **Intervention group 2** • HA uncemented; Austin-Moore (Stryker/Howmedica Ltd, Newbury, UK) • Randomised = 200; losses = 119 (died by end of follow-up); analysed = 200 **Note:** • study authors did not report the following intervention details: type of anaesthesia

Parker 2010d *(Continued)*

Outcomes	**Outcomes measured/reported by study authors:** pain (VAS; scale of 1 to 10, lower numbers indicate less pain; data available at: 8 weeks: 3, 6, and 9 months; 1, 2, 3, 4, 5 years); mobility scale (Parker mobility score: 0 to 9; lower scores indicate better mobility; data available at: 8 weeks: 3, 6, and 9 months; 1, 2, 3, 4, 5 years); mortality; length of hospital stay; need for blood transfusion; complications (confusion, pneumonia, pressure sores, DVT, pulmonary embolism, CVA, GI bleed, cardiac failure, acute renal failure, MI, acute cardiac arrhythmia, acute confusion state, intestinal obstruction, clostridia diarrhoea, peritonitis); wound healing complications (wound haematoma, superficial infection, deep wound infection, dislocation, drainage of infection or haematoma, internal fixation revised to HA, revision arthroplasty for periprosthetic fracture, revision for pain to THA, revision for dislocation to THA, girdlestone arthroplasty, girdlestone arthroplasty and later THA, any re-operation) **Outcomes relevant to the review:** unplanned return to theatre (revision); mortality (at 2 to 3 months, 12 months and 5 years) **Note:** • 12-month mortality data provided by study author; data for early mortality taken from Parker 2010a • unplanned return to theatre: reasons for re-operation were subsidence, dislocation, infection, loosening and acetabular wear; types of re-operation were replacement with arthroplasty, Girdlestone and drainage of infection
Notes	**Funding/sponsorship/declarations of interest:** support by a grant from the Peterborough Hospital Hip Fracture Fund **Study dates:** March 2001 to November 2006

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation is not described
Allocation concealment (selection bias)	Low risk	Quote: "randomised by the opening of a sealed opaque numbered envelope, prepared by a person independent of the study"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	The surgeon in the study was experienced in both techniques
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population. We noted data were not complete for pain and mobility at 5 years.
Other bias	Low risk	We identified no other sources of bias

Parker 2010d *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Parker 2012

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented ETS versus cemented Thompson
Participants	**Total number of randomised participants:** 200 **Inclusion criteria:** people with a displaced intracapsular fracture **Exclusion criteria:** pathological fractures from secondary tumour or local bone disease; fracture of the same hip that had previous surgical treatment; fractures being treated conservatively; patients declined to participate; senile dementia; significant arthritis of the hip to be treated with THA; fractures treated by internal fixation; patients treated when lead trialist was not available to supervise the surgical procedure **Setting:** hospital; single centre; UK **Baseline characteristics** **Intervention group 1** (Exeter Trauma Stem) • Age, mean (range): 84.9 (63 to 97) years • Gender, M/F, n: 14/86 • Mobility assessment, mobility score, mean: 3.9 • Place of residence, from own home, n: 77 • Cognitive status, mental test score, mean: 6.3 • ASA status, mean: 2.7 • ASA status, I or II, n: 36 **Intervention group 2** (Thompson) • Age, mean (range): 83.6 (61 to 97) years • Gender, M/F, n: 11/89 • Mobility assessment, mobility score, mean: 4.0 • Place of residence, from own home, n: 77 • Cognitive status, mental test score, mean: 6.8 • ASA status, mean: 2.7 • ASA status, I or II, n: 39 **Note:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities, preoperative waiting times
Interventions	**General details:** performed or supervised by 1 orthopaedic surgeon (study author) with patient in the lateral position; all patients mobilised as soon as able with restrictions placed on hip movements or weight bearing; routine follow-up at 6 weeks, then by telephone at 3, 6, 9 and 12 months **Intervention group 1** • HA cemented; monoblock Exeter Trauma Stem HA (Stryker Corporation)

Parker 2012 *(Continued)*

	• Randomised = 100 **Intervention group 2** • HA cemented Thompson prosthesis (Corin Surgical Ltd) • Randomised = 100 **Note:** • study authors did not report the following intervention details: type of anaesthesia
Outcomes	**Outcomes measured/reported by study authors:** length of surgery, difficulty level of surgery, retained cement in the joint, laceration of the limb at surgery, operative fracture femur, required blood transfusion, volume of blood transfused, wound haematoma, superficial or deep wound infection, dislocation, acetabular wear, length of hospital stay, complications (cardiac arrest at surgery, pneumonia, pressure sores, DVT, pulmonary embolism, delirium, CVA, cardiac failure, cardiac arrhythmia, clostridia diarrhoea, GI bleed, urine retention, acute renal failure), mean pain scores and mean change in mobility scores (data available at 8 weeks, and at 3, 6, 9 and 12 months); mortality (30 days, 90 days, 120 days, 1 year); unplanned return to theatre **Outcomes relevant to the review:** mortality (120 days and 1 year); unplanned return to theatre **Notes:** • unplanned return to theatre: reasons for re-operation were dislocation and acetabular wear; types of re-operation were replacement with arthroplasty
Notes	**Funding/sponsorship/declarations of interest:** no external sources of funding; internal funding from the Peterborough Hospital Hip Fracture fund **Study dates:** November 2006 to July 2009 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Parker 2015

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF versus HA
Participants	**Total number of randomised participants:** 56 **Inclusion criteria:** males aged > 50 years of age; displaced intracapsular fracture **Exclusion criteria:** life expectancy of greater than ten years; very frail patients at high surgical risk from cemented hemiarthroplasty; delay between injury and presentation of more than two days; surgeon felt a comorbidity affected the choice of treatment **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1** (IF) • Age, mean (range): 81.5 (62 to 94) years • Gender, M/F: 30 male

Parker 2015 *(Continued)*

- Mobility assessment, mean mobility score: 3.5
- Place of residence, from own home, n: 24
- ASA status, grade 1 or 2, n: 6
- Additional information:
  - Social dependency score, mean: 3.5

Intervention group 2 (specify by name)

- Age, mean (range): 81.2 (65 to 91) years
- Gender, M/F: 26 male
- Mobility assessment, mean mobility score: 3.2
- Place of residence, from own home, n: 22
- ASA status, grade 1 or 2, n: 7
- Additional information:
  - Social dependency score, mean: 3.6

Note:

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

Interventions	**General details:** operations were undertaken or directly supervised by a single experienced surgeon; mobilised fully weight bearing after surgery; protocols for postoperative care were identical for both; thromboprophylaxis with low-molecular-weight heparin for 28 days; clinical and patient-reported follow up at 8 weeks, 3, 6, 9 and 12 months **Intervention group 1:** • IF; using Targon FN; fracture table and image intensification, with closed reduction • Randomised = 30; no loss to follow-up; analysed = 30 **Intervention group 2:** • HA; cemented, unipolar, Exeter trauma stem (ETS) inserted via an antero-lateral approach • Randomised = 26; no loss to follow-up; analysed = 26
Outcomes	**Outcomes measured/reported by study authors:** all at 12 months: pain using a modified Charnley-pain score, a mobility scale and a social dependency score; length of stay in hospital; infections; re-operation; mortality; adverse events: blood transfusions, pneumonia, atrial fibrillation, myocardial infarction, acute renal injury, urinary retention, deep vein thrombosis, pressure sores **Outcomes relevant to the review:** unplanned return to theatre (at 12 months); mortality (at 1 and 12 months)
Notes	**Funding/sponsorship/declarations of interest:** authors stated no conflicts of interest **Study dates:** January 2012 and October 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Low risk	Quote: “numbered sealed opaque envelope, prepared by an individual independent to the study”
Blinding of participants and personnel (performance bias)	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance

Parker 2015 *(Continued)*
All outcomes

Other performance bias: surgeon experience of both implants	Low risk	The surgeon in the study was experienced in both techniques
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss to follow-up
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration documents. It is not feasible to effectively assess risk of selective reporting bias without these documents

Parker 2019

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA versus HA
Participants	**Total number of randomised participants:** 105 **Inclusion criteria:** displaced intracapsular fracture; able to walk independently out of doors with no more than the use of a stick; not cognitively impaired; medically fit **Exclusion criteria:** < 60 years of age; where internal fixation was felt to be the best treatment; degenerative arthritis of the hip; acetabular dysplasia; senile dementia **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1** (THA) • Age, mean (range): 77.1 (67 to 89) years • Gender, M/F, n: 12/40 • Mobility assessment, mean: 1.6 • Place of residence, own home, n: all • Cognitive status, mental test score mean: 8.7 • ASA status, mean: 2.2. Status I or II: 36 • Additional information: ◦ social dependency grade, mean: 1.1 **Intervention group 2** (HA)

Parker 2019 *(Continued)*

- Age, mean (range): 77.1 (60 - 89) years
- Gender, M/F, n: 8/45
- Mobility assessment, mean: 1.4
- Place of residence, own home, n: all
- Cognitive status, mental test score mean: 8.9
- ASA status, mean; 2.0. Status I or II: 46
- Additional information:
  - social dependency grade, mean: 1.1

Note:

- study authors did not report: smoking history, medication, BMI, comorbidities, place of residence

Interventions	**General details:** performed or supervised by 1 orthopaedic surgeon; both interventions were cemented; general anaesthesia was given to 26 participants in the HA group and 29 participants in the THA group; weight bearing as able; routine follow-up at 8 weeks; clinical follow-up phone calls at 3, 6, 9 and 12 months from injury and then annually. Mean follow-up was approximately 3 years and all participants had a minimum follow-up of 1 year **Intervention group 1** • THA; 29 were a CPCS stem (Smith & Nephew Ltd) and the remainder CPT Zimmer stems; acetabular cups were cemented polyethylene with a 32 mm internal diameter; advised to limit flexion of the hip beyond 90° for 8 weeks • Randomised = 52; losses = 4 (died at 1 year); analysed = 52 **Intervention group 2** • HA; 22 were monoblock Exeter Trauma Stems (Smith & Nephew Ltd), 4 CPT bipolar HAs (CPT Zimmer Corporation Ltd) and the remainder CPT modular HA • Randomised = 53; losses = 2 (died at 1 year); analysed = 51 **Note:** • study authors do not report number of clinicians or their experience, use of prophylactic antibiotics or antithromboembolics, or time to weight bearing
Outcomes	**Outcomes measured/reported by study authors:** pain (scale: 1 (no pain) to 8 (constant and severe); available at 8 weeks, 3 months, 6 months, 9 months, 12 months); walking/mobility ability (scale: 1 (no walking aid) to 9 (wheelchair-bound); available at 8 weeks, 3 months, 6 months, 9 months, 12 months); social dependence (scale: 1 (completely independent) to 8 (hospital inpatient); available at 8 weeks, 3 months, 6 months, 9 months, 12 months); length of stay in hospital; superficial wound infection; deep wound infection; haematoma; urinary retention; DVT; pressure sores; delirium; CVA; fat embolism/cement reaction; blood transfusion; mortality (data available at 30 days, 4 months and 1 year) **Outcomes relevant to the review:** mortality (4 months and 12 months); unplanned return to theatre **Note:** • unplanned return to theatre: reasons for re-operation were dislocation, acetabular wear and periprosthetic fracture; types of re-operation were replacement with arthroplasty, closed reduction and internal fixation
Notes	**Funding/sponsorship/declarations of interest:** study authors report no commercial funding **Study dates:** December 2012 to February 2018

Risk of bias

Bias	Authors' judgement	Support for judgement

Parker 2019 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Low risk	Quote: "numbered sealed opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	The surgeon in the study was experienced in both techniques
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participant loss was because of death, which is expected in this population. Study authors reported that no participant was lost to follow-up
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Retrospective registration with a clinical trials register (NCT02998359; first received December 2016); only mobility stated as outcome a priori, with more outcomes reported in paper. We could not feasibly use these retrospectively registered documents to assess risk of selective reporting bias

Parker 2020

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 400 **Inclusion criteria:** displaced intracapsular fracture; able to walk independently out of doors with no more than the use of a stick; not cognitively impaired **Exclusion criteria:** "younger patients"; where internal fixation or total hip arthroplasty were felt to be the best treatment; mental impairment; considered unfit for a cemented arthroplasty; degenerative arthritis of the hip; pathological fractures; acetabular dysplasia **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1** (cemented)

Parker 2020 *(Continued)*

- Age, mean (range): 84.2 (60 to 102) years
- Gender, M/F, n: 67/133
- Place of residence, from own home, n: 160
- Mobility assessment, mean (SD): 4.0 (± 1.7)
- Cognitive status, mental test score, mean (SD): 6.6 (± 3.1)
- ASA status, I/II/III/IV, n: 1/35/134/30; frequency (SD): 3.0 (± 0.6)
- Additional information:
  - social dependency grade, mean (SD): 3.4 (± 2.1)

Intervention group (uncemented)

- Age, mean (range): 85.3 (58 to 98) years
- Gender, M/F, n: 60/140
- Place of residence, from own home, n: 169
- Mobility assessment, mean (SD): 4.1 (± 1.7)
- Cognitive status, mental test score, mean (SD): 6.4 (± 3.1)
- ASA status, I/II/III/IV, n: 1/24/133/32; frequency (SD); frequency: 3.0 (± 0.6)
- Additional information:
  - social dependency grade, mean (SD): 3.5 (± 1.9)

Note:

- study authors did not report: smoking history, medication, BMI, comorbidities

Interventions

General details: Hardinge direct lateral approach to the hip; surgery was undertaken or directly supervised by the lead trialist (in all but 8 operations); general anaesthesia given to 91 participants in the cemented group and 101 participants in the uncemented group; fully weight bearing with no postoperative restrictions on weight bearing or hip movement

Intervention group 1

- HA cemented; unipolar double-tapered stem (Exeter Trauma Stem, Stryker Medical, Michigan, USA, or CPT Zimmer/Biomet, Warsaw, Indiana, USA)
- Randomised = 200; losses = 51 (died at 12 months); analysed = 200

Intervention group 2

- HA uncemented; fully hydroxyapatite-coated Furlong (JRI Orthopaedics, Sheffield, UK)
- Randomised = 200; losses = 64 (died at 12 months); analysed = 200

Outcomes

Outcomes measured/reported by study authors: functional assessments; hip movements; limb shortening; pain (data available at 8 weeks; 3, 6, 9 and 12 months); walking/mobility (data available at 8 weeks; 3, 6, 9 and 12 months); social dependence (data available at 8 weeks; 3, 6, 9 and 12 months); pneumonia; congestive cardiac failure; MI; cardiac arrhythmia; urinary retention; DVT; pulmonary embolism; pressure sores; delirium; CVA; gastrointestinal bleed; acute renal failure; clostridia diarrhoea; fat embolism; mortality (data available at 30 days, 120 days and 1 year); blood transfusion; length of hospital stay

Outcomes relevant to the review: mortality (4 and 12 months)

Notes

Funding/sponsorship/declarations of interest: no commercial funding. Funding for research nurse was provided by Peterborough Hip Fracture Project Research Fund

Study dates: December 2012 to February 2018

Note:

- study currently reports 12-month follow-up but participants will be followed up at 36 months (study report to follow)

Parker 2020 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "envelopes were prepared, sealed, randomly mixed, and then numbered by an individual independent of the study"
Allocation concealment (selection bias)	Low risk	Quote: "sealed, identical, opaque envelopes "
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	The surgeon in the study was experienced in both techniques
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most participant loss was because of death, which is expected in this population. Although study authors reported no other participant losses, we noted missing data for a very small number of participants for participant-reported outcomes; we did not expect these losses to influence effect estimates for these outcomes
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Retrospective registration with clinical trials register (NCT02998034: first received December 2016). It was not feasible to effectively assess risk of reporting bias using these documents

Patel 2008

Study characteristics

Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar
Participants	**Total number of randomised participants:** 40 **Inclusion criteria:** people > 70 years of age, presenting with intracapsular hip fractures (Garden's III or IV) **Exclusion criteria:** not reported **Setting:** single centre; hospital; location not reported **Baseline characteristics not reported** **Note:**

Patel 2008 *(Continued)*

	• study authors reported no baseline details and we could not be certain whether prognostic factors were comparable between groups
Interventions	**General details:** all operations performed through a Hardinge approach by the same surgical team. All prostheses were uncemented. Rehabilitation with same physiotherapist using same routine **Intervention group 1** • HA bipolar (medical international); uncemented • Randomised = 20; no losses; analysed = 20 **Intervention group 2** • HA unipolar; Thompson hemiarthroplasty; uncemented • Randomised = 20; 1 loss (reason not reported): analysed = 19 **Note:** • study authors do not report number of clinicians or their experience, type of anaesthesia, use of prophylactic antibiotics or antithromboembolics, or time to weight bearing
Outcomes	**Outcomes measured/reported by study authors:** mortality (in hospital); length of hospital stay; deep infections; periprosthetic fracture; return to pre-injury state; pain; participant satisfaction with procedure **Outcomes relevant to the review:** mortality **Note:** • median follow-up time was 13 months
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** not reported **Note:** • study is published only as an abstract which limits the amount of detail available

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as a randomised study, but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to types of interventions but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that all interventions were performed by the same team but we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data

Patel 2008 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Loss of only 1 participant
Other bias	High risk	Study reported only as an abstract which we assumed was not peer-reviewed. In addition, there is limited information in the study report and we could not be certain of other potential biases
Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trial registration or prepublished protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents

Pathi 1989

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF versus HA
Participants	**Total number of randomised participants:** 45 (10 lost to follow up) **Inclusion criteria:** 60 to 75 years of age; Garden's III and IV; within 3 weeks of injury **Exclusion criteria:** pathological fractures **Setting:** unclear number and type of setting; India **Baseline characteristics** **Overall:** • Gender, M/F: 23/12 **Note:** • No details reported for each group for: age, smoking history, medication, BMI, comorbidities, mobility, place of residence, cognitive status, ASA status, preoperative waiting time
Interventions	**General details:** postoperative derotation boot for 2 weeks; sitting and quadriceps exercises on day 2; weight bearing from week 4; routine follow-up 3 monthly **Intervention group 1:** • IF; 5 received nails with plating; 10 Garden screws • Randomised = 15 **Intervention group 2:** • HA; uncemented; 18 using Watson Jone approach; 7 Thompson; 13 Austin Moore • Randomised = unclear **Note:** • No details of number of clinicians (and their skills and experience), type of anaesthesia, use of prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** pain; mobility; failure; wound haemotoma; postoperative fracture; infection; non-union; AVN

Pathi 1989 *(Continued)*

	Outcomes relevant to the review: none
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** not reported **Note:** • we did not complete risk of bias assessment because this study reported no relevant review outcomes

Paus 1986

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Total number of randomised participants:** 131 **Inclusion criteria:** displaced femoral neck fractures (classified as Garden's III or IV); < 80 years of age **Exclusion criteria:** 2 participants were excluded quote: "on general medical grounds" and were treated with arthroplasty, 1 participant was excluded because of living abroad **Setting:** single centre; hospital; Norway **Baseline characteristics (overall)** • Age, median: male 64 years; female 70 years • Gender, M/F: 26/105 • Use of walking aides: no aid 104; 1 stick 18; two sticks/crutches 8; bedridden 1 • Cognitive status/dementia: dementia present in 6% • Preoperative waiting time, mean (SD): 22% "the following day" • Fracture classification: Garden's III, n: 16; Garden's IV, n: 115 **Note:** • study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, BMI, place of residence,
Interventions	**General details:** 4 experienced surgeons completed 40 operations, 26 less experienced surgeons (without orthopaedic training) completed the remaining 91; no traction applied on admission; analgesics provided; reduction completed on fracture table with x-ray monitor; partial weight bearing for 6 weeks; anticoagulants prescribed **Intervention group 1** • Screws (von Bahr) - 2 screws • Randomised = 65; no losses; analysed = 65 **Intervention group 2** • Richard's hip compression - 2 Steinmann pins, thread 12 mm • Randomised = 66; no losses; analysed = 66
Outcomes	**Outcomes measured/reported by study authors:** deep infection; dislocation; non-union; AVN; mortality; re-operation; all follow-up 2 to 18 months

Paus 1986 *(Continued)*

	Outcomes relevant to the review: unplanned return to theatre; mortality (deaths from 2 to 18 months) **Notes:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty, refixation or removal of fixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** 1980 to 1983

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not described
Allocation concealment (selection bias)	Unclear risk	Concealment not clearly described
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Surgeries performed by experienced and inexperienced clinicians. It is uncertain whether surgeons were equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration; it is not feasible to effectively assess risk of selective reporting bias without these documents

Puolakka 2001

Study characteristics

Methods	RCT; parallel design **Review comparison group:** IF versus HA

Puolakka 2001 *(Continued)*

Participants	**Total number of randomised participants:** 32
	
	Inclusion criteria: > 75 years of age; Garden's III or IV
	
	Exclusion criteria: not able to walk prior to fracture and rheumatoid arthritis
	
	Setting: single setting, hospital, Finland
	
	Baseline characteristics
	
	Intervention group 1 (IF)
	
	• Age, mean (range): 81 (76 to 88) years
	• Gender, M/F: 4/13
	• Mobility assessment, walking ability, n:
	  ○ indoors: 4
	  ○ 100 to 500 m: 5
	  ○ 500 to 1000 m: 3
	  ○ > 1000 m: 5
	• Place of residence, n:
	  ○ Home: 13
	  ○ Home for aged: 4
	  ○ Hospital: 0
	
	Intervention group 2 (HA)
	
	• Age, mean (range): 82 (77 to 90) years
	• Gender, M/F: 1/14
	• Mobility assessment, walking ability, n:
	  ○ indoors: 5
	  ○ 100 to 500 m: 3
	  ○ 500 to 1000 m: 1
	  ○ > 1000m: 6
	• Place of residence, n:
	  ○ Home: 9
	  ○ Home for aged: 4
	  ○ Hospital: 1
	
	Note:
	
	• authors did not report: smoking history, medication, BMI, comorbidities, cognitive status, ASA status, preoperative waiting time

Interventions	**General details:** operated within 3 days of injury; resident surgeons; immediate mobilisation with weight bearing restricted if possible for 12 weeks (IF) or 6 weeks (HA); clinical follow-up at 6 weeks, 3, 12 and 24 months **Intervention group 1** • IF; 3 Ullevaal screws; skeletal traction if operation not performed in 24 hours; closed reduction on fracture table; participants excluded if reduction could not be achieved (1 participant) • Randomised = 17; no reported loss to follow-up; analysed = 17 **Intervention group 2** • HA; cemented Thompson; posterior approach • Randomised = 15; no reported loss to follow-up; analysed = 15
Outcomes	**Outcomes measured/reported by study authors:** mortality (at 3 and 24 months); re-operations at 24 months (assumed); AVN; operation time, blood loss; wound infections; complications

Puolakka 2001 *(Continued)*

	Outcomes relevant to the review: mortality (at 3 and 24 months); unplanned return to theatre (at 24 months, assumed)
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** start date February 1994, no end date reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as sealed envelope method, no additional details
Allocation concealment (selection bias)	Unclear risk	Described as sealed envelope method. Study authors do not report if envelopes were opaque and sequentially-numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind personnel to interventions. We did not expect lack of blinding to influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	It is not clear if resident surgeons were equally experienced with both techniques in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not believe that lack of blinding would influence data for this outcome
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trial registration or prepublished protocol; it is not feasible to effectively assess risk of reporting bias without these documents

Raia 2003

Study characteristics

Methods	RCT; parallel design **Review comparison group:** HA: bipolar vs unipolar
Participants	**Total number of randomised participants:** 115 **Inclusion criteria:** ≥ 65 years of age, with an acute displaced femoral neck fracture (Garden's III to IV)

Raia 2003 *(Continued)*

Exclusion criteria: people with dementia; nonambulatory; pathologic femoral neck fractures; additional acute lower extremity fracture in addition to the femoral neck fracture; living in nursing homes

Setting: single centre; hospital; USA

Baseline characteristics

Intervention group 1 (bipolar)

- Age, mean (range): 82.4 (65 to 95) years
- Gender, M/F, n: 13/42
- Comorbidities, Charlson index score, mean: 2.0
- Mobility assessment, community/ household, n: 45/10

Intervention group 2 (unipolar)

- Age, mean (range): 81.8 (65 to 101) years
- Gender, M/Fn: 19/41
- Comorbidities, Charlson index score, mean: 2.1
- Mobility assessment, community/ household, n: 48/12

Note:

- study authors did not report baseline characteristics for: smoking history, medication, BMI, place of residence, cognitive status, ASA status, preoperative waiting times

Interventions	**General details:** surgery done within 24 to 48 hours of hospital admission. Preoperative heparin, prophylactic antibiotics started preoperatively, and warfarin for 6 weeks postoperatively. Anaesthesia type at the discretion of the anaesthetists (majority were regional anaesthesia). Mobilised to full-weight bearing on POD 1 with supervision of physical therapists **Intervention group 1** • HA bipolar (Centrax; Howmedica, Rutherford, USA); use of an appropriate-sized cemented Premise stem (Howmedica, Rutherford, USA) • Randomised = 55; losses = 17 (12 died; 5 could not be reached or declined to answer follow-up questionnaires); analysed for mortality = 55 **Intervention group 2** • HA unipolar (Unitrax; Howmedica, Rutherford, USA); use of an appropriate-sized cemented Premise stem (Howmedica, Rutherford, USA) • Randomised = 60; losses = 20 (12 died; 8 could not be reached or declined to answer follow-up questionnaires); analysed for mortality = 60 **Note:** • study authors do not report number of clinicians or their skills/experience
Outcomes	**Outcomes measured/reported by study authors:** mortality; estimated blood loss; number of participants requiring blood transfusion; length of stay on orthopaedic ward; complications (urinary tract and haematoma; pulmonary embolism and re-operation); dislocations; quality of life (QoL: SF-36; separately reported scores for physical function; bodily pain; role limitations physical; role limitations emotional; mental health; social functioning; vitality; general health); mobility and ADL (Musculoskeletal Functional Assessment Instrument Scores; lower score indicates better function; at 1 year) **Outcomes relevant to the review:** mortality (1 year); HRQoL (SF-36; physical function; at 1 year) **Note:** • data for re-operation were not reported separately, and we therefore could not use these data in analyses

Raia 2003 *(Continued)*

	• it is not clear if scores for HRQoL are mean or median scores; these scores are reported without distribution values and we did not include in analyses
Notes	**Funding/sponsorship/declarations of interest:** 1 study author received funding as a consultant for Stryker Howmedica Osteonics **Study dates:** May 1997 to January 2000

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect lack of blinding of objective measures to influence the outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses were owing to death, which is expected in this population. Loss to follow-up at 12 months was clearly explained and balanced between groups
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Rashed 2020

Study characteristics

Methods	RCT; parallel design **Review comparison group:** THA: dual-mobility cups versus conventional large head
Participants	**Total number of randomised participants:** 62 **Inclusion criteria:** 55 to 80 years of age, and displaced femoral neck fracture (Garden's III and IV) **Exclusion criteria:** cognitive dysfunction (as evidenced by > 4 errors on the SPMSQ); dependency in daily living activities as proved by the Katz ADL index; previous hip surgery; old non-united femoral-neck fractures; neuromuscular disorders; previous prolonged nonambulation; preoperative ASA

Rashed 2020 *(Continued)*

	score > III; presence of other injuries or fractures; upper or lower limb amputation; inflammatory arthropathies; arthritic acetabulum; pathological femoral neck fractures **Setting:** single centre; hospital; Egypt **Baseline characteristics** **Intervention group 1** (dual-mobility cups) • Age, mean: 66.38 years • Gender, M/F, n: 16/15 • ASA status I/II/III, n: 4/15/12 • Comorbidities, diabetic/hypertensive/hepatitis C positive, n: 7/4/2 **Intervention group 2** (conventional) • Age, mean: 68 years • Gender, M/F: 14/17 • ASA status I/II/III, n: 10/16/5 • Comorbidities: diabetic/hypertensive/hepatitis C positive, n: 6/4/3 **Note:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, place of residence, cognitive status, ASA status, preoperative waiting times
Interventions	**General details:** 4 senior arthroplasty surgeons using the posterior approach; physiotherapy was initiated as per a modified protocol, participants routinely followed-up at 12 weeks, 16 weeks, 6 months and 1 year **Intervention group 1** • THA cemented dual-mobility cup (Ecofit 2M, Implantcast GmbH, Germany); median cup size: 46 mm (range 44–52 mm); median polyethylene liner size: 40 mm (range 38–46 mm) • Randomised = 31; losses = 1 (owing to death); analysed = 31 **Intervention group 2** • THA cemented 32 mm head total hip replacement (Implantcast GmbH, Germany) • Randomised = 31; losses = 1 (owing to death); analysed = 31 **Note:** • study authors do not report number of clinicians or their skills/experience
Outcomes	**Outcomes measured/reported by study authors:** HHS (available at 3, 4, 6 and 12 months); range of motion; HRQoL (SF-36); mortality; superficial wound infection; deep infection; dislocation; DVT; heterotopic ossification; neurovascular injury; limb-length discrepancy **Outcomes relevant to the review:** mortality **Note:** • we did not include HRQoL in the review because these data were reported in a figure from which we could not confidently extract numerical data
Notes	**Funding/sponsorship/declarations of interest:** study authors received no funding and declared no conflicts of interest **Study dates:** April 2014 to May 2015 **Note:**

Rashed 2020 *(Continued)*

- we attempted to contact study authors by email to ask for data for HRQoL but we received no reply

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "computer-generated randomisation list that was created by a statistician prior to the commencement of the study"
Allocation concealment (selection bias)	Low risk	Managed by a statistician
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that the interventions were performed by all senior surgeons but we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors reported that no participants were lost to follow-up. Only participant loss was because of death, which is expected in this population
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Ravikumar 2000

Study characteristics

Methods	Quasi-RCT; parallel design **Review comparison group:** THA versus HA versus IF
Participants	**Total number of randomised participants:** 180 **Inclusion criteria:** > 65 years of age; displaced subcapital femoral neck fracture (Garden's III and IV) **Exclusion criteria:** old fractures; pathological fractures; rheumatoid arthritis **Setting:** single centre; UK **Intervention group 1** (THA) • Age, mean: 81.03 years **Intervention group 2** (HA) • Age, mean: 82.06 years

Ravikumar 2000 *(Continued)*

	Intervention group 3 (IF) • Age, mean: 79.73 years **Note:** • study authors do not report baseline characteristics for: gender, medication, comorbidities, smoking history, place of residence, mobility assessment, ASA status, preoperative waiting times • study authors report that: "Differences between the groups as regards age, gender and preoperative mobility were not significant at the 5% level"
Interventions	**General details:** surgery by orthopaedic trainees and occasionally consultants; mobilised with full-weight bearing **Intervention group 1** • THA; cemented with Howse II prosthesis using a semicaptive cup and a 32 mm head • Randomised = 89 **Intervention group 2** • HA; uncemented Austin-Moore prosthesis • Randomised = 91 **Intervention group 3** • IF; Richards compression screw and plate • Randomised = 91
Outcomes	**Outcomes measured/reported by study authors:** pain and mobility (Sikorski 1981; available at 1 year and 13 years); HHS (at 13 years); loss of mobility; infection (13 years); dislocation (13 years); revision (13 years); adverse events: pulmonary embolism; myocardial infarction; perioperative deaths; peroneal nerve palsy; iatrogenic femoral fracture; mortality (available at 2 months, 12 months, 13 years) **Outcomes relevant to the review:** unplanned return to theatre (revision)
Notes	**Funding/sponsorship/declarations of interest:** funded by Johnson & Johnson **Study dates:** December 1984 to December 1986 **Note:** • this study is linked to another publication (Skinner 1989); we have collected some information (for example, methods used to randomise participants to group) from the Skinner 1989 publication • we did not complete risk of bias assessment because we did not include this study within a network; the study compared an old design with a modern design and introduced inconsistency within the network for unplanned return to theatre.

Rehman 2014

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 110 **Inclusion criteria:** displaced intracapsular hip fracture (Garden's type III and IV); > 60 years of age; either gender

Rehman 2014 *(Continued)*

Exclusion criteria: pathological hip fractures; previous treatment to same hip for a fracture; significant arthritis for the hip assessed radiologically

Setting: multicentre; 2 hospitals and 1 research institute; Pakistan

Baseline characteristics

Intervention group 1 (cemented)

- Age, mean (SD): 68.44 (± 6.74) years
- Gender, M/F, n: 35/20
- Mobility assessment (scale 0 to 9); higher number indicates better mobility), mean (SD): 7.2 (± 0.75)

Intervention group 2 (uncemented)

- Age, mean (SD): 71.24 (± 8.74) years
- Gender, M/F, n: 29/26
- Mobility assessment (scale 0 to 9; higher number indicates better mobility), mean (SD): 7.2 (± 0.75)

Note:

- study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities, place of residence, cognitive status, ASA status, preoperative waiting time

Interventions	**General details:** operations performed or supervised by the same orthopaedic surgeon, and by a standard lateral approach. All participants received perioperative prophylactic antibiotics, and 14 days of low-molecular-weight heparin as thromboembolic prophylaxis. After surgery, all participants were mobilised as soon as possible, with no restriction on hip movement or weight bearing; patients reviewed at 4, 8 and 12 weeks **Intervention group 1** • HA cemented with Thompson prosthesis • Randomised = 55 **Intervention group 2** • HA uncemented with Austin-Moore prosthesis • Randomised = 55 **Note:** • study authors did not report the following intervention details: type of anaesthesia
Outcomes	**Outcomes measured/reported by study authors:** pain (assessed using a pain scale of 0 to 6); mobility (scale of 0 to 9); reported at 12 weeks **Outcomes relevant to the review:** none
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** August 2010 to August 2013 **Note:** • we did not complete risk of bias assessment because this study reported no relevant review outcomes

Rehnberg 1989

Study characteristics

Rehnberg 1989 *(Continued)*

Methods	RCT; parallel design **Review comparison group:** screw versus screw
Participants	**Total number of randomised participants:** 222 **Inclusion criteria:** admitted to the department for a femoral neck fracture **Exclusion criteria:** pathological fractures; inability to reduce fractures; severe coxarthrosis; fractures > 1 week old **Setting:** single centre; university hospital; Sweden **Baseline characteristics** **Intervention group 1** (Uppsala screw) • Age, mean (SD): 80 (± 9) years • Gender, M/F: 27/84 • Fracture classification, undisplaced/displaced, n: 27/84 **Intervention group 2** (von Bahr) • Age, mean (SD): 80 (± 8) years • Gender, M/F: 28/83 • Fracture classification, undisplaced/displaced, n: 25/86 **Notes:** • study authors state "there were no differences between the two treatment groups as regards preinjury living condition and need for walking aids" • In addition, some baseline characteristics (mobility assessment and place of residence) are available in a table within the study report; we have not included these data because we are unable to read the very small print in the study report. Study authors do not report any of the following baseline characteristics: smoking history, medication, BMI, comorbidities, cognitive status, ASA status, preoperative waiting times
Interventions	**General details:** operations performed by 29 different surgeons (skills and experience were not reported); mobilisation was allowed with full weight bearing on POD1; follow-up performed by clinical and radiographic examination at 4 and 12 months **Intervention group 1** • Uppsala screws • Randomised = 111 **Intervention group 2** • von Bahr screws • Randomised = 111 **Notes:** • study authors did not report the following intervention details: type of anaesthetic, use of prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by the study authors:** pain; need for walking aids; place of residence at 12 months follow-up; complications (penetration of the fixation device into the joint, loosening, non-union, late segmental collapse; mortality **Outcomes relevant to the review:** mortality (12 months)

Rehnberg 1989 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** March 1986 to July 1987 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Ren 2017

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA versus HA
Participants	**Total number of randomised participants:** 100 **Inclusion criteria:** people with femoral neck fractures **Exclusion criteria:** not reported **Setting:** single centre; hospital; China **Baseline characteristics** **Intervention group 1** (THA) • Age, mean (SD): 69.49 (± 3.32) years • Gender, M/F, n: 28/22 **Intervention group 2** (HA) • Age, mean (SD): 69.73 (± 3.51) years • Gender, M/F, n: 27/23 **Notes:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, cognitive status, ASA status, preoperative waiting time, type of fracture classification
Interventions	**General details:** no details of procedure are reported **Intervention group 1** • THA; acetabular and femoral prosthesis used according to individual patient • Randomised = 50 **Intervention group 2** • HA; cemented; no additional details • Randomised = 50 **Notes:** • study authors do not describe the following intervention details: number of clinicians (and their skills or experience), type of anaesthesia, use of prophylactic antibiotics and antithromboembolics

Ren 2017 *(Continued)*

Outcomes	**Outcomes measured/reported by study authors:** operative variables (operation time, volume of blood loss); time until out of bed; complications (types not defined); functional status (with HHS; time point not specified) **Outcomes relevant to the review:** none
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** October 2015 to March 2017 **Note:** • we did not complete risk of bias assessment because this study reported no relevant review outcomes

Roden 2003

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF versus HA
Participants	**Total number of randomised participants:** 100 **Inclusion criteria:** over 70 years of age, displaced femoral neck fracture, able to walk before fracture **Exclusion criteria:** previous hip disease, senility, presentation to hospital beyond 12 hours from fracture event **Setting:** single centre, hospital, Sweden **Baseline characteristics** **Intervention group 1** (IF) • Age, mean (range): 81 (70-96) years • Gender, M/F: 16/37 **Intervention group 2** (Biploar HA) • Age, mean (range): 81 (70-96) years • Gender, M/F: 13/34 **Note:** • study authors reported no details for each group for: smoking history, medication, BMI, comorbidities, mobility, place of residence, cognitive status, ASA status, preoperative waiting time,
Interventions	**General details:** 12 experienced surgeons; operated with 24 hours of admission; spinal anaesthesia; thromboembolic prophylaxis with low-molecular-weight heparin for one week; clinical examination at 4 months, 1 and 2 years and a telephone interview by an experienced senior nurse at 5 to 6 years **Intervention group 1:** • IF; two von Bahr screws; using fluoroscopy, the fractures were reduced in the operating room • Randomised = 53; no reported loss to follow-up; analysed = 53 **Intervention group 2:** • HA; bipolar, cemented, Variokopf - 28 mm head; antibiotic prophylaxis (cloxacillin/diclocil) for 4 days; posterior Moore incision in the lateral position

Roden 2003 *(Continued)*

- Randomised = 47; no reported loss to follow-up; analysed = 47

Note:

- no details reported on rehabilitation and weight bearing

Outcomes	**Outcomes measured/reported by study authors:** displacement; AVN; screw migration; non-union; infection; cerebrovascular lesion; pulmonary embolism; dislocation; heterotrophic bone formation; function; re-operation (unclear time point); mortality (at 2 years and 5/6 years) **Outcomes relevant to the review:** unplanned return to theatre (unclear time point, assumed to be duration of study); mortality (at 2 years and 5/6 years)
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** February 1992 to September 1994

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes; study authors do not report if envelopes are sequentially-numbered and opaque
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Although the number of surgeons is reported, study authors do not report whether surgeons are equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were clearly reported with most owing to death
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Rogmark 2002

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF versus arthroplasty (including HA and THA)

Participants	**Total number of randomised participants:** 409
	
	Inclusion criteria: age 70 years and above; Garden's III or IV
	
	Exclusion criteria: confusion; rheumatoid arthritis; bedridden or confined to a nursing-home; fractures older than two days
	
	Setting: 12 hospitals; Sweden
	
	Baseline characteristics
	
	Intervention group 1 (IF)
	
	• Age, mean: 81.5 years
	• Gender, M/F: 47/170
	
	Intervention group 2 (arthroplasty)
	
	• Age, mean: 81.5 years
	• Gender, M/F: 38/154
	
	Overall:
	
	• Age, mean (SD):
	  ○ women: 81.8 (± 5.8) years
	  ○ men: 80.7 (± 5.9) years
	
	Note:
	
	• No details reported for each group for: smoking history, medication, BMI, comorbidities, mobility, place of residence, cognitive status, ASA status, preoperative waiting time,
	• not possible to determine whether prognostic variables are comparable between groups

Interventions	**General details:** hospitals used the type of prosthesis and surgical approach with which they were familiar; postoperative care in both groups was the same; early weight bearing was encouraged; regular physiotherapy was provided; surgeons involved were experienced with the techniques of fixation and arthroplasty
	
	Intervention group 1:
	
	• IF; types used, n:
	  ○ Hansson hook-pins 200
	  ○ Olmed screws 17
	• Randomised 217
	
	Intervention group 2:
	
	• THA (n = 103)
	  ○ Exeter 33
	  ○ Charnley 32
	  ○ Lubinus 19
	  ○ Scanhip 14
	  ○ Others 5

Rogmark 2002 *(Continued)*

- Hemiarthroplasty (n = 89)
  - Variokopf 41
  - Moore 17
  - Charnley-Hastings 14
  - Others 17
- Total randomised to arthroplasty group = 192

Note:

- authors did not report: type of anaesthesia, pre- and postoperative care (e.g. use of prophylactic antibiotics or antithromboembolics)
- 450 participants originally identified, but 41 were excluded due to cancelled surgery, loss to follow-up, failure of inclusion criteria, refusal to continue or death before procedure

Outcomes	**Outcomes measured/reported by study authors:** mortality (during hospital stay, 4, 12 and 24 months); non-union; AVN; deep infection; pain; dislocation; fracture; infection; discharge destination; pulmonary and/or cardiac insufficiency; stroke; venous thromboembolic complication; re-operation at 2 years **Outcomes relevant to the review:** mortality (4 and 12 months); unplanned return to theatre at 24 months
Notes	**Funding/sponsorship/declarations of interest:** financial support was obtained from Trygg-Hansa Research Foundation, Greta & Johan Kock Foundation and the Malmö University Hospital Research Funds **Study dates:** 1995 to 1997 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Sadr 1977

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented vs uncemented
Participants	**Total number of randomised participants:** 40 **Inclusion criteria:** emergency admissions with subcapital fractures of the femoral neck; displaced fractures (Garden's III or IV) **Exclusion criteria:** undisplaced (Garden's I); pathological fractures **Setting:** single centre; hospital; UK **Baseline characteristics** **Intervention group 1** (cemented) • Age, average: 77 years • Gender, M/F, n: 7/13 **Intervention group 2** (uncemented) • Age, average: 78.4 years • Gender, M/F, n: 3/17

Sadr 1977 *(Continued)*

	Note: • study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status
Interventions	**General details:** surgery within first week of injury (usually within 72 hours); "a number of different surgeons"; using anterolateral and posterior approaches; early mobility with unrestricted weight bearing on POD 2; discharged from hospital when independently mobile with a walking aid, or transferred to a rehabilitation unit within 3 to 4 weeks of surgery **Intervention group 1** • HA cemented; Thompson prosthesis; coated with acrylic cement • Randomised = 20; losses = 9 (died); analysed = 20 **Intervention group 2** • HA uncemented; Thompson prosthesis; coated with polytetrafluorethylene (Proplast) • Randomised = 20; losses = 6 (4 died; 2 did not attend follow-up appointments); analysed = 20 **Note:** • study authors did not report the following intervention characteristics: type of anaesthesia; exact number of surgeons and their skills or experience; use of prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** loosening of prosthesis; dislocation; ectopic calcification; mortality; functional status **Outcomes relevant to the review:** mortality (6 weeks and 12 months) **Note:** • follow-up time period ranged from 3 to 17 months
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "allocated to one or other group by random selection" Comment: no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study

Sadr 1977 *(Continued)*

Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were clearly reported with most owing to death
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Santini 2005

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** HA: cemented vs uncemented
Participants	**Total number of randomised participants:** 106 **Inclusion criteria:** ≥ 65 years of age with femoral neck fractures; also included participants < 65 years old with fractures secondary to malignant tumours but with life expectancy > 3 months **Exclusion criteria:** pathological fractures, with life expectancy inferior to 3 months **Setting:** single centre; hospital; Italy **Baseline characteristics** **Intervention group 1** (cemented) • Age, mean (SD): 82.09 (± 7.6) years • Gender, M/F: 13/40 • Comorbidities, pre-existing conditions, n: 0 to 1: 26; 2: 16; 3 to 4: 11 • Place of trauma, home/institutions for the elderly/walking outdoors/in hospital, n: 43/5/3/2 • Place of residence, lived alone/with relatives/geriatric institutions, n: 19/27/7 • ASA status, I/II/III/IV, n: 4/18/29/2 • Preoperative waiting time, mean (SD): 2.67 (± 1.4) days **Intervention group 2** (uncemented) • Age, mean (SD): 79.68 (± 8.62) years • Gender, M/F, n: 11/42 • Comorbidities, pre-existing conditions, n: 0 to 1: 27; 2: 10; 3 to 4: 16 • Place of trauma, home/institutions for the elderly/walking outdoors/in hospital, n: 39/10/3/1 • Place of residence, lived alone/with relatives/geriatric institutions, n: 20/22/11 • ASA status, I/II/III/IV, n: 2/24/23/4 • Preoperative waiting time, mean (SD): 2.72 (± 1.26) days **Note:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, mobility assessment, cognitive status, fracture displacement

Santini 2005 *(Continued)*

Interventions	**General details:** skin traction until surgery; spinal anaesthesia in all participants; surgical procedure using a lateral approach in supine position; full weight bearing on POD3; blood transfusion according to haemoglobin levels preoperatively and postoperatively; radiographic follow-up at 6 months **Intervention group 1** • HA cemented endoprosthesis with bipolar head • Randomised = 53 **Intervention group 2** • HA uncemented endoprosthesis with bipolar head • Randomised = 53 **Note:** • study authors did not report the following intervention details: number of clinicians (and their skills or experience), use of prophylactic antibiotics and antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** mortality (in-hospital; at 1 year); postoperative complications (MI, cardiac arrhythmia, pneumonia, pulmonary embolism, thrombophlebitis, UTI, gastric disease; deep wound infection, prosthesis dislocation, iatrogenic femoral fracture); length of hospital stay; functional recovery; discharge destination **Outcomes relevant to the review:** mortality (at hospital discharge and 12 months)
Notes	**Funding/sponsorship/declarations of interest:** no external funding **Study dates:** September 2000 to December 2001 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Sernbo 1990

Study characteristics	
Methods	RCT; single centre; parallel design **Review comparison group:** smooth pin versus smooth pin
Participants	**Total number of randomised participants:** 410 **Inclusion criteria:** people with cervical hip fractures **Exclusion criteria:** fractures older than 1 week, pathological fractures and unreducible fractures excluded **Setting:** single centre; hospital; Sweden **Baseline characteristics (overall)** • Age, mean (SD): M - 76 (± 12) years; F - 77 (± 10) years • Gender, M/F: 104/306 • Fracture classification, undisplaced/displaced: 118/292 **Notes:**

Sernbo 1990 *(Continued)*

- study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, BMI, mobility assessment, place of residence, cognitive status, preoperative waiting time

Interventions	**General details:** 33 orthopaedic surgeons; tibial pin traction; closed reduction; no prophylactic antibiotic; 96% spinal anaesthesia; full weight bearing the day after the operation **Intervention group 1** • Rydell Nail - four-flanged spring-loaded single nail • Randomised = 205 **Intervention group 2** • Hansson hook pin - two LIH hook-pins • Randomised = 205
Outcomes	**Outcomes measured/reported by study authors:** early displacement; extraction after healing; nonunion; late segmental collapse; failure; salvage arthroplasty (reported at 24 months); discharge to own home **Outcomes relevant to the review:** unplanned return to theatre **Notes:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation not reported
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** March 1984 to December 1985 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Sharma 2016

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA versus HA
Participants	**Total number of randomised participants:** 80 **Inclusion criteria:** people with displaced femoral neck fractures, > 60 years of age **Exclusion criteria:** associated osteoarthritis, AVN, rheumatoid arthritis, pathological fractures due to any other cause; people with significant comorbidities **Setting:** single centre; hospital; India **Baseline characteristics** **Intervention group 1** (THA) • Age, mean (range): 78 (65 to 79) years • Gender, M/F, n: 14/26 • Preoperative waiting time, mean: 3 days

Sharma 2016 *(Continued)*

	• Fracture classification, Garden's III/IV, n: 18/22 **Intervention group 2** (HA) • Age, mean (range): 73 (62 to 77) years • Gender, M/F, n: 11/29 • Preoperative waiting time, mean: 3 days • Fracture classification, Garden's III/IV, n: 14/26 **Note:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, ASA status
Interventions	**General details:** all surgeries performed by one of two senior arthroplasty surgeons using modified Gibson approach (Gibson 1950); weight bearing allowed as soon as pain threshold permitted **Intervention group 1** • THA; no additional details • Randomised = 40 **Intervention group 2** • HA; no additional details • Randomised = 40 **Notes:** • study authors did not report the following intervention details: type of anaesthesia, use of prophylactic antibiotics or antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** operative variables (surgery time, volume of blood loss, mean units of transfused blood); wound infection; time to ambulation; time to achieve preoperative status; dislocation; abductor laxity; functional status; early mortality **Outcomes relevant to the review:** mortality (reported for 1 participant at 7 days)
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** 2010 to 2014 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Sikorski 1981

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF versus HA (two approaches: anterior and posterior)
Participants	**Total number of randomised participants:** 218 **Inclusion criteria:** age 70 years or over, displaced (Garden's III or IV)

Sikorski 1981 *(Continued)*

Exclusion criteria: long-standing fracture, rheumatoid arthritis, malignant deposits and if treatment was strongly indicated towards one type of intervention

Setting: single setting; hospital; UK

Baseline characteristics

Overall:

- Age, mean (SD): 80.37 (± 6.21) years
- Gender, M/F: 35/183

Note:

- No details reported for: smoking history, medication, BMI, comorbidities, mobility, place of residence, cognitive status, ASA status, preoperative waiting time,

Interventions	**General details:** performed by trainees; mobilised with full weight bearing on second day; followed up at 3 month intervals (or less) **Intervention group 1:** • IF; two Garden screws • Randomised = 104; 28 could not be reduced; so number analysed is 76; 52 reported for revision at 3 months, 44 at 24 months; losses due to mortality and loss to follow-up **Intervention group 2:** • HA; cemented Thompson; either anterior or posterior approaches (two distinct groups); posterior group were not allowed to sit and were 'nursed flat for two weeks' • Randomised = 114; 57 in each group; 85 reported for revision at 3 months (48+37) and 69 at 24 months (41+28); losses due to mortality and loss to follow-up
Outcomes	**Outcomes measured/reported by study authors:** mortality at 1, 3, 6, 12 and 24 months; complications: cardiac failure, respiratory infection, urinary infection, wound infection; treatment failure; revision at 3 and 24 months; mobility **Outcomes relevant to the review:** unplanned return to theatre (at 3 and 24 months) **Note:** • followed up for two years (or death) or until 2 weeks after the first revision operation • mortality not reported in analysis because it was not possible to extract from the figure
Notes	**Funding/sponsorship/declarations of interest:** conflicts of interest were not reported **Study dates:** January 1977 to January 1980

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomised by drawing a card from a box. However, if randomised to IF but reduction could not be achieved, the participant was re-allocated to the HA group; we believed that this increased risk of selection bias
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias)	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance

Sikorski 1981 *(Continued)*
All outcomes

Other performance bias: surgeon experience of both implants	Unclear risk	Although the number of surgeons is reported, study authors do not report whether surgeons are equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were clearly reported with most owing to death
Other bias	Low risk	No other bias observed
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Sims 2018

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: ETS versus Thompson

Participants	**Total number of randomised participants:** 964
	
	Inclusion criteria: > 60 years of age; type B3 fracture (displaced)
	
	Exclusion criteria: pre-existing symptomatic hip arthritis
	
	Setting: multicentre; 5 hospitals; UK
	
	Baseline characteristics
	
	Intervention group 1 (Exeter/ Unitrax)
	
	• Age, mean (SD): 83.9 (± 7.9) years
	• Gender, M/F, n: 156/326
	• Cognitive status, using AMTS, mean (SD): 6.6 (± 3.7)
	• Place of residence. n:
	  ○ own home/sheltered housing: 277
	  ○ residential care: 57
	  ○ nursing home: 29
	  ○ rehabilitation unit: 2
	  ○ investigator's hospital: 6
	  ○ other hospital within same trust: 9
	  ○ other hospital trust: 0
	• ASA status, I/II/III/IV, n: 2/84/230/63

Sims 2018 *(Continued)*

- Preoperative waiting time, mean (SD): 28.5 (± 21.0) hours

Intervention group 2 (Thompson)

- Age, mean (SD): 83.7 (± 7.3) years
- Gender, M/F, n: 156/326
- Cognitive status, using AMTS, mean (SD): 6.4 (± 3.8)
- Place of residence, n:
  - own home/sheltered housing: 271
  - residential care: 57
  - nursing home: 33
  - rehabilitation unit: 2
  - investigator's hospital: 4
  - other hospital within same trust: 1
  - other hospital trust: 2
- ASA status, I/II/III/IV, n: 1/78/240/49
- Preoperative waiting time, mean (SD): 28.2 (± 23.4) hours

Note:

- study authors did not report baseline characteristics for: smoking history; medication; BMI; comorbidities; mobility assessment/use of walking aides

Interventions	**General details:** multiple surgeons; pre- and postoperative management was as per the standard of care in the unit, according to NICE guidance **Intervention group 1** • HA cemented Exeter/Unitrax (Stryker Ltd., Newbury, UK); modular polished taper stem • Randomised = 482 **Intervention group 2** • HA cemented Thompson • Randomised = 482 **Note:** • study authors report allocation of 482 participants to each group, but 155 participants withdrew before consent was given, some participants also withdrew or were withdrawn from the study after consent, and other losses were owing to death
Outcomes	**Outcomes measured/reported by study authors:** EQ-5D-5L (4 months); mortality; walking ability; length of stay; complications; radiological neck length **Outcomes relevant to the review:** mortality (4 months); HRQoL (4 months)
Notes	**Funding/sponsorship/declarations of interest:** funded by Stryker **Study dates:** February 2015 and March 2016 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Sonaje 2017

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** THA versus HA
Participants	**Total number of randomised participants:** 42 **Inclusion criteria:** > 60 years of age with closed intracapsular displaced femoral neck fracture, giving informed consent **Exclusion criteria:** ipsilateral lower limb fractures, with psychiatric and neurological disorders, not giving informed consent **Setting:** single centre; hospital; India **Baseline characteristics** **Intervention group 1** (THA; for analysed participants only) • Age, mean (range): 66.4 (60 to 74) years • Gender, M/F, n: 7/13 • Fracture classification, Garden's III/IV, n: 9/11 **Intervention group 2** (HA; for analysed participants only) • Age, mean (range): 65.3 (61 to 73) years • Gender, M/F, n: 6/14 • Fracture classification, Garden's III/IV, n: 7/13 **Note:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, preoperative waiting time
Interventions	**General details:** all surgeries performed on elective basis, using standard aseptic procedures, under spinal anaesthesia. In all cases, the stem was cemented in place using standard cement techniques **Intervention group 1** • THA; no further details reported; cemented stem • Randomised = 21; losses = 1 (reason for loss was not clearly specified - either owing to death or loss to follow-up): analysed = 20 **Intervention group 2** • HA bipolar; no further details reported; cemented • Randomised = 21; losses = 1 (reason for loss was not clearly specified - either owing to death or loss to follow-up): analysed = 20 **Note:** • study authors did not report the following intervention details: number of clinicians (and their skills or experience), manufacturer names, prophylactic antibiotics or antithromboembolics, postoperative weight-bearing regimen
Outcomes	**Outcomes measured/reported by study authors:** intraoperative variables (duration of surgery, volume of blood loss); pain scores; limp; use of walking support; walking distance; ability to put on shoes and socks; stair climbing; sitting; entering public transportation; deformity of the hip; range of movements; functional modified HHS; complications (death, periprosthetic fracture, bed sore, prosthetic dislocation, minor limb length discrepancy)

Sonaje 2017 *(Continued)*

	Outcomes relevant to the review: mortality **Note:** • we did not include data for mortality because it was not clear to which group these participants belonged • all cases followed up for 24 months
Notes	**Funding/sponsorship/declarations of interest:** no external funding. Study authors declare no conflicts of interest **Study dates:** September 2011 to November 2012 Note: • we did not complete risk of bias assessment because we could not use data from this study in the network

Sonne-Holm 1982

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 112 **Inclusion criteria:** admitted to hospital with a femoral neck fracture, > 70 years of age, with fracture sustained within the past week, with no orthopaedic or neurological disorders influencing gait function **Exclusion criteria:** not specified **Setting:** single centre; hospital; Denmark **Baseline characteristics not reported**
Interventions	**General details:** performed as emergency procedures **Intervention group 1** • HA cemented; Moore prosthesis, anchored with methylmethacrylate bone cement • Randomised = 55; losses = 15 (11 = died before first follow-up; 3 = wrong prosthesis inserted for technical reasons; 0 = transferred to another hospital; 1 = refusal to co-operate); analysed = 55 **Intervention group 2** • HA uncemented; Moore prosthesis • Randomised = 57; losses = 22 (11 = died before first follow-up; 6 = wrong prosthesis inserted for technical reasons; 3 = transferred to another hospital; 2 = refusal to co-operate); analysed = 57 **Note:** • study authors did not report the following intervention details: number of clinicians (and their skills and experience), type of anaesthetic, use of prophylactic antibiotics or antithromboembolics, postoperative weight-bearing regimen
Outcomes	**Outcomes measured/reported by study authors:** hip function (includes total scores, and scores for pain, mobility and gait function at 6 weeks, 3 months, 6 months, and 12 months); mortality; superficial infection; periarticular calcification; osteolysis; settling of the prosthesis

Sonne-Holm 1982 *(Continued)*

	Outcomes relevant to the review: mortality (before first follow-up; we assumed that this was at 6 weeks)
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** all recruited in 1979

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Participants were randomly allocated to groups but no additional details. We also noted that baseline characteristics were not reported
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Although the number of surgeons is reported, study authors do not report whether surgeons are equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	Large number of losses, but mostly caused by death which is expected in this population. All losses were well reported.
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Soreide 1979

Study characteristics

Methods	Quasi-RCT; parallel design **Review comparison group:** IF versus HA
Participants	**Total number of randomised participants:** 104 **Inclusion criteria:** aged over 67 years of age; acute femoral neck fracture (Garden's II to IV) **Exclusion criteria:** none reported **Setting:** single setting, hospital, Sweden **Baseline characteristics**

Soreide 1979 *(Continued)*

	Intervention group 1 (IF) • Age, mean: 77.9 years **Intervention group 2** (HA) • Age, mean: 78.3 years **Note:** • No details reported for each group for: gender, smoking history, medication, BMI, comorbidities, mobility, place of residence, cognitive status, ASA status, preoperative waiting time
Interventions	**General details:** tibial traction on admission; prophylactic antithrombosis from first day; surgery within 7 days; as part of surgical training **Intervention group 1:** • IF; von Bahr screws, no antibiotics, weight bearing as soon as tolerated • Randomised = 51 **Intervention group 2:** • HA; cemented Christiansen trunnion-bearing hip prosthesis; cloxacillin and penicillin administered • Randomised = 53
Outcomes	**Outcomes measured/reported by study authors:** superficial infections; haematoma; complications: thromboembolism, cardiopulmonary, neurological, drug exanthema, urinary retention, luxation, AVN, failure; mortality rates (1, 6 and 12 months); length of stay in hospital; re-operation (12 months); walking ability; function (including pain) **Outcomes relevant to the review:** mortality rates (1 and 12 months); unplanned return to theatre (12 months)
Notes	**Funding/sponsorship/declarations of interest:** conflicts of interest were not reported **Study dates:** October 1974 to September 1976 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Stoffel 2013

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar
Participants	**Total number of randomised participants:** 294 **Inclusion criteria:** people with displaced intracapsular fracture of the femoral neck who met the criteria for treatment with cemented hemiarthroplasty **Exclusion criteria:** significant communication disorders, nonambulatory after surgery, previous symptomatic hip pathology, resident outside the hospital's service zone **Setting:** hospital; single centre; Australia

Stoffel 2013 *(Continued)*

	Baseline characteristics (overall; only for those who were not excluded**)** • Gender, M/F: 89/172 **Intervention group 1** (bipolar) • Age, mean (SD): 82.9 (± 9.7) years • ASA status, mean (SD): 2.9 (± 0.8) **Intervention group 2** (unipolar) • Age, mean (SD): 81.9 (± 8.8) years • ASA status, mean (SD): 2.7 (± 0.6) **Note:** • study authors did not report baseline characteristics for: gender in each group, smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, preoperative waiting times, fracture classification
Interventions	**General details:** procedures done by 15 registrars and 8 consultants; standardised rehabilitation programme **Intervention group 1** • HA bipolar; cemented prosthesis with bipolar head (Smith & Nephew, Memphis, USA), with a collarless polished cemented stem inserted using the Hardinge approach • Number randomised to group is not reported **Intervention group 2** • HA unipolar; cemented prosthesis with unipolar head (Smith & Nephew, Memphis, USA), with a collarless polished cemented stem inserted using the Hardinge approach • Number randomised to group is not reported **Note:** • study authors did not report the following intervention details: type of anaesthetic, use of prophylactic antibiotics and antithromboembolics, time to weight bearing after surgery
Outcomes	**Outcomes measured/reported by study authors:** OHS; HHS; verbal numerical rating score for pain; 6MWT; hip range of motion (all at 12 months after surgery); postoperative complications (dislocation, CVA, delirium/confusion, encephalopathy, DVT, MI, chest infection, pneumonia, heart failure/pulmonary oedema, renal failure/acidosis, UTI, wound infection (superficial; deep) **Outcomes relevant to the review:** none
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** June 2005 to June 2007 **Note:** • we did not complete risk of bias assessment because this study reported no relevant review outcomes

Strömquist 1984

Study characteristics	
Methods	Quasi-RCT; parallel design

Strömquist 1984 *(Continued)*

	Review comparison group: smooth pin versus smooth pin
Participants	**Total number of randomised participants:** 152 **Inclusion criteria:** all intracapsular femoral neck fractures in people ≥ 50 years of age **Exclusion criteria:** not reported **Setting:** single centre; university hospital; Sweden **Baseline characteristics** **Intervention group 1** (Rydell four-flanged nail) • Age, mean (we assumed range): 79 (53 to 95) years • Fracture classification, undisplaced/displaced, n: 18/52 (using Garden's) **Intervention group 2** (Hansson hook pin) • Age, mean (we assumed range): 78 (52 to 94) years • Fracture classification, undisplaced/displaced, n: 24/58 (using Garden's) **Notes:** • study authors did not report the following baseline characteristics: gender, smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, preoperative waiting times
Interventions	**General details:** preoperative tibial traction for all displaced fractures, postoperative scintimetry 1 to 2 weeks after nailing; 1 of 6 surgeons performed operation; prophylactic antibiotics were not used; full weight bearing from POD1 for all participants **Intervention group 1** • four-flanged nail (Rydell) • Randomised = 70 cases **Intervention group 2** • 2 hook pins (Hansson) • Randomised = 82 cases **Notes:** • study authors did not report skills or experience of surgeons, or type of anaesthetics
Outcomes	**Outcomes measured/reported by study authors:** complications (redisplacement/non-union; segmental collapse); deep infections; mortality (available at 4 months, 12 months and 24 months) **Outcomes relevant to the review:** mortality (at 24 months; data by group only reported at 24 months time point); unplanned return to theatre (re-operation because of redisplacement or non-union) **Note:** • radiographic and clinical follow-up at 4, 12, and 24 months (or until re-operation or death) • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty or removal of fixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** January 1981 to February 1982 **Note:**

Strömquist 1984 *(Continued)*

- we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Strömquist 1988

Study characteristics	
Methods	Quasi RCT; parallel design **Review comparison group:** screws versus smooth pins
Participants	**Total number of randomised participants:** 110 **Inclusion criteria:** people attending with a fracture of the femoral neck **Exclusion criteria:** not reported **Setting:** hospital, single centre; Sweden **Baseline characteristics** **Intervention group 1** (AO screws) • Fracture classification, undisplaced/displaced: 16/37 **Intervention group 2** (Hook pins) • Fracture classification, intracapsular - undisplaced/displaced: 18/39 **Overall** • Age, mean (range): 77 (33 to 92) years • Gender, M/F: 27/83 • Preoperative waiting time: surgery performed the day after admission
Interventions	**General details:** displaced fractures received traction by tibial pin, intervention carried out on an orthopaedic table; immediate weight bearing; all members of the orthopaedic team completed surgery **Intervention group 1** • AO screws, two used • Randomised = 53; losses = 7 (2 lost to follow-up, 5 deaths); analysed = 51 **Intervention group 2** • Hook pins, two used • Randomised = 57; losses = 6 (1 lost to follow-up, 5 deaths); analysed = 56
Outcomes	**Outcomes measured/reported by study authors:** mortality; re-operations; fixation ratio **Outcomes relevant to the review:** mortality (at 4 months); unplanned return to theatre (at 4 months) **Notes:** • unplanned return to theatre: reasons for re-operation not reported; types of re-operation were removal of fixation
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Strömquist 1988 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quasi-randomised, allocated according to being born on even/odd days
Allocation concealment (selection bias)	High risk	Not possible to conceal allocation
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors do not report whether surgeons are equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Few losses which were explained and balanced between groups
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Svenningsen 1984

Study characteristics

Methods	RCT; parallel design **Review comparison group:** fixed angle plate versus fixed angle plate versus HA Note: • study included 2 comparison groups: fixed angle plate vs fixed angle plate vs arthroplasty (for participants > 70 years of age), and fixed angle plate vs fixed angle plate (for participants < 70 years of age). Study authors reported combined data from the 2 types of fixed angle plates and we have therefore reported these together in the review.
Participants	**Total number of randomised participants:** 255 **Inclusion criteria:** all patients < 70 years and > 70 years with undisplaced fracture received compression screw or nail plate; those > 70 years received compression screw, nail plate or primary prosthetic

Svenningsen 1984 *(Continued)*

Exclusion criteria: not reported

Setting: single centre; hospital; Norway

Baseline characteristics (overall)

- Age, mean (SD): 71 years

Note:

- study authors did not report baseline characteristics by group, nor did they report any baseline data for: smoking history, BMI, mobility assessment, place of residence, cognitive status, preoperative waiting time

Interventions	**General details:** 17 trainee surgeons; closed reduction and internal fixation; preoperative skeletal traction for displaced fractures; thrombosis prophylaxis; no antibiotics used; anaesthetic: spinal (n = 42), epidural (n = 179), general (n = 34); early full weight bearing encouraged; clinical follow-up at: 3 months, 6 months and at 1, 2 and 3 years **Intervention group 1** • Compression screw with plate (Benosit Girard); compression screw; cannulated sliding lag screw and a barrel-plate combination; shaft diameter being 7 mm, maximal thread width 14 mm, and thread length 20 mm; plate is fixed to the subtrochanteric region of the femur • Randomised = 128 **Intervention group 2** • Thornton trifin nail combined with the McLaughlin plate; inserted at a steep angle through the femoral neck into the central lower part of the femoral head • Randomised = 127 **Intervention group 3** • Christiansen HA • Randomised = 59
Outcomes	**Outcomes measured/reported by study authors:** duration of the operation, blood transfusions, fall in the haemoglobin level 1 week postoperatively, postoperative complications (superficial infection; DVT), mortality rate and length of hospitalisation. Failure of healing - recurrence of fracture and non-union **Outcomes relevant to the review:** mortality (12 months)
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** October 1977 to January 1980 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Sørensen 1992

Study characteristics	
Methods	RCT; parallel design **Review comparison:** screw versus fixed angle plate

Sørensen 1992 *(Continued)*

Participants	**Total number of randomised participants:** 73 **Inclusion criteria:** all adults with nonpathological intracapsular femoral neck fractures, Garden's II to IV; informed consent **Exclusion criteria:** Garden's I fractures **Setting:** single centre; university hospital; Denmark **Baseline characteristics** **Intervention group 1** (Gouffon screws) • Age, mean (SD): 76.53 (± 9.65) years • Gender, M/F: 8/30 • Fracture classification, Garden's I, n: 0; Garden's II, n: 5; Garden's III, n: 22; Garden's IV, n: 11 **Intervention group 2** (DHS) • Age, mean (SD): 76.14 (± 8.57) years • Gender, M/F: 10/25 • Fracture classification, Garden's I, n: 0; Garden's II, n: 5; Garden's III, n: 21; Garden's IV, n: 9 **Notes:** • study authors do not report the following baseline characteristics: smoking history, medication, BMI, comorbidities, place of residence, mobility assessment, cognitive status, ASA status, preoperative waiting times
Interventions	**General details:** operations performed as emergencies by orthopaedic registrar on duty. All fractures reduced. weight bearing was allowed as soon as the participant was mobilised, usually within 1 or 2 days **Intervention group 1** • 3 Gouffon screws (Howmedica, Inc) • Randomised = 38; losses = 0; analysed = 38 **Intervention group 2** • Dynamic hip screws (Synthes) • Randomised = 35; losses = 3 (lost to final follow-up for walking ability and pain); analysed = 35 **Note:** • study authors do not report the following intervention details: number of registrars who performed operations; prophylactic antibiotics and antithromboembolics
Outcomes	**Outcomes measured/reported by study authors:** mortality; complications (redisplacement, non-union, osteonecrosis); re-operation; social function; walking ability; hip-related pain; spina-malleo-lus-shortening **Outcomes relevant to the review:** mortality; unplanned return to theatre (re-operation - removal of implant, hemiarthroplasty, total hip arthroplasty) **Note:** • study authors state that clinical and radiographic follow-up was performed by one of the study inves-tigators 1 or 2 days postoperatively, and after 3 months, 6 months, 1 year and 3 years. Time points for reported data are unclear; we have assumed that all data are reported at end of follow-up (3 years) • sample size was planned for 260 participants; study authors do not report for which outcome this calculation was based. Planned subgroup analysis was not described

Sørensen 1992 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** start date February 1985, end date not reported **Note:** • study terminated early because of a difference in failure rate between the two methods (more failure with Guoffon screws). Original sample size was planned for 260 participants • study authors presented individual patient data in a table; we used this table to calculate mean values and count numbers of participants for baseline characteristics and for some outcome data

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Study is described as randomised, and participants were randomly allocated to treatment groups, but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors do not report whether attending surgeon was equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Only 3 participants provided no outcome data for pain or mobility at the end of follow-up. Data available for all other participants (including those who died during the study period)
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Talsnes 2013

Study characteristics

Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented

Talsnes 2013 *(Continued)*

Participants	**Total number of randomised participants:** 334 **Inclusion criteria:** admitted for cervical hip fracture with displaced Garden's III to IV fractures; > 75 years of age **Exclusion criteria:** patients not residing locally (because of the difficulties with follow-up) **Setting:** multicentre; 2 hospitals; Norway **Baseline characteristics** **Intervention group 1** (cemented) • Age, mean (SD): 84.3 (± 5) years • Gender, M/F, n: 45/117 • Cognitive impairment, n: 40 • ASA status, I/II/III/IV, n: 6/62/81/13 **Intervention group 2** (uncemented) • Age, mean (SD): 84 (± 5.1) years • Gender, M/F, n: 37/135 • Cognitive impairment, n: 47 • ASA status, I/II/III/IV, n: 4/64/91/13 **Note:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, preoperative waiting times
Interventions	**General details:** no details on surgery were reported **Intervention group 1** • HA cemented; bipolar implant (Landos Titan, Depuy, Warshaw, IN, USA) • Randomised = 162; no reported losses; analysed = 162 **Intervention group 2** • HA uncemented; bipolar implant (Landos Corail, Depuy, Warshaw, IN, USA) • Randomised = 172; no reported losses; analysed = 172 **Note:** • study authors did not report the following intervention details: number of clinicians (and their skills and experience), type of anaesthesia, use of prophylactic antibiotics or antithromboembolics, postoperative mobility/weight-bearing regimen
Outcomes	**Outcomes measured/reported by study authors:** all-cause mortality (12 months); surgery time; volume of blood loss; need for blood transfusion; haemoglobin concentration **Outcomes relevant to the review:** mortality (12 months)
Notes	**Funding/sponsorship/declarations of interest:** Charnley Grant from Orthomedic, and financial support from Centre of Medical Science, Innlandet Hospital Trust, Elverum, Norway **Study dates:** 2005 to 2010

Risk of bias

Bias	Authors' judgement	Support for judgement

Talsnes 2013 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Quote: "A nurse in the operating theatre conducted the randomisation by opening one of the block randomised envelopes stating whether the prosthesis should be cemented or non cemented" Comment: insufficient information on method of randomisation
Allocation concealment (selection bias)	Unclear risk	Use of envelopes, but study authors do not report if envelopes are opaque, sealed, and sequentially numbered
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment group but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors do not report the number of surgeons and whether their skills and experience are comparable for both interventions
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study report states that the study is registered with a clinical trials register; no identification number is reported, and we were unable to verify this. It is not feasible to effectively assess risk of selective reporting bias without this information

Taylor 2012

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 160 **Inclusion criteria:** ≥ 70 years of age; acutely displaced fracture deemed by the attending surgeon to be suitable for hemiarthroplasty **Exclusion criteria:** people with a previous fracture of the same hip; pathological fracture; suitability for receiving a cemented component was made by the attending anaesthetist - participants were excluded if the risk of death was unacceptable (based on patient age, pre-existing cardiovascular or respiratory disease, or history of bone cement implantation syndrome) **Setting:** single centre; hospital; New Zealand **Baseline characteristics (overall)** • Age, mean (range): 85.2 (70 to 99.4) years **Intervention group 1** (cemented)

Taylor 2012 *(Continued)*

- Age, mean (SD): 85.3 (± 7) years
- Gender, M/F, n: 23/57
- Comorbidities, using CCI, mean (SD): 5.95 (± 1.2)
- ASA status, mean (SD): 2.95 (± 0.49)
- Place of residence, living in own home, n: 40

Intervention group 2 (uncemented)

- Age, mean (SD): 85.1 (± 6.6) years
- Gender, M/F, n: 27/53
- Comorbidities, using CCI, mean (SD): 5.98 (± 1.26)
- ASA status, mean (SD): 2.99 (± 0.53)
- Place of residence, living in own home, n: 47

Note:

- study authors did not report baseline characteristics for: smoking history, medication, BMI, mobility assessment, cognitive status, preoperative waiting time

Interventions

General details: carried out using modified Hardinge surgical approach, performed under supervision of 12 consultant surgeons experienced with both procedures (majority of procedures performed by registrars); all participants received 1 g cephazolin intraoperatively and 2 additional doses at 8 and 16 hours postoperatively; all received routine observation, analgesia, and prophylaxis against DVT; allowed to mobilise with full weight bearing as tolerated; clinical examinations at 6 weeks, 6 months, 1 and 2 years

Intervention group 1

- HA cemented; modular Exeter stem with an appropriately-sized UniTrax head (Stryker Orthopaedics, Mahwah, New Jersey)
- Randomised = 80; no losses; analysed = 80

Intervention group 2

- HA uncemented; Zweymüller Alloclassic stem with an appropriately-sized head (Centerpulse, Zurich, Switzerland)
- Randomised = 80; no losses; analysed = 80

Note:

- study authors did not report type of anaesthesia; this was given at the discretion of the attending anaesthetist, along with fluid management and treatment of intraoperative hypotension

Outcomes

Outcomes measured/reported by study authors: pain (VAS); functional status (OHS; and SMFA); cognitive function (MMSE); mobility (TUG, use of walking aids); ability to live independently; mortality (6 weeks, 6 months, 1 year, 2 years); unplanned return to theatre; complications (cardiovascular, respiratory infections, superficial or deep wound infection, UTI, postoperative fracture, intraoperative fracture, dislocation, re-operation); length of stay

Outcomes relevant to the review: mortality (6 weeks, 1 year); unplanned return to theatre (assumed to be within 2 year follow-up period)

Note:

- unplanned return to theatre: reasons for re-operation not reported; types of re-operation were not reported

Notes

Funding/sponsorship/declarations of interest: funded by the New Zealand Orthopaedic Association, the Wishbone Trust, and the Accident Compensation Corporation (Wellington, New Zealand)

Study dates: May 2006 to November 2008

Taylor 2012 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Low risk	Use of sequentially numbered, sealed and opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment group but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	Supervised by senior surgeons who were experienced with both types of techniques
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	No participant losses
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Registered with Australian New Zealand Clinical Trials Register. Study authors do not report identification number and we were unable to check whether the study was registered prospectively; it is not feasible to effectively assess selective reporting bias without these documents

Tidermark 2003

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF versus THA
Participants	**Total number of randomised participants:** 110 **Inclusion criteria:** 70 years of age or older, no evidence of severe cognitive dysfunction, domestic independence and ability to walk with or without walking aids, displaced fractures **Exclusion criteria:** pathological fractures, fractures more than 24 hours old and patients with chronic arthritis **Setting:** single centre, hospital, Sweden

Tidermark 2003 *(Continued)*

Baseline characteristics (for participants who received treatment)

Intervention group 1 (IF)

- Age, mean (SD): 81.4 (± 6.6) years
- Gender, M/F: 11/42
- Comorbidities, grade A (full health) or B (another illness not affecting rehabilitation), n: 44
- Mobility assessment, no walking aides or just one cane, n: 46
- Cognitive status, SPMSQ, mean (SD): 8.7 (± 1.6)
- Additional information:
  - EQ-5D prior to surgery, mean (SD): 0.84 (± 0.13)
  - ADL, Katz index (A or B), n: 51

Intervention group 2 (THA)

- Age, mean (SD): 79.2 (± 5.0) years
- Gender, M/F: 9/40
- Comorbidities, grade A (full health) or B (another illness not affecting rehabilitation), n: 40
- Mobility assessment, no walking aides or just one cane: 45
- Cognitive status, SPMSQ, mean (SD): 9.0 (± 1.1)
- Additional information:
  - EQ-5D prior to surgery, mean (SD): 0.8 (± 0.22)
  - ADL, Katz index (A or B), n: 48

Note:

- study authors did not report: smoking history, medication, BMI, place of residence, ASA status, pre-operative waiting time

Interventions	**General details:** two surgeons carried out operations for both groups, experienced general orthopaedic surgeons; low-molecular-weight heparin preoperatively and daily for approximately ten days after surgery; no antibiotic prophylaxis was given to IF group but THA group received antibiotic prophylaxis (cefuroxime) preoperatively followed by two doses during the first 24 hours; both groups were mobilised bearing full weight as tolerated; clinical and radiological review at 4 and 24 months **Intervention group 1:** • IF, two cannulated screws (Olmed); lateral projection, parallel screw placements • Randomised = 55: 2 excluded due to being unfit for surgery or unwilling to participate; 53 received treatment; analysed for mortality and unplanned return to theatre = 53; analysed for HRQoL = 41 **Intervention group 2:** • THA, Exeter modular stem (Stryker, Sweden); head diameter 28 mm; OGEE acetabular component (De Puy, Sweden); anterolateral approach • Randomised = 55, 6 excluded due to being unfit for surgery; analysed for mortality and unplanned to theatre = 53; analysed for HRQoL = 43
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 24 and 48 months); re-operation (available at 24 and 48 months); the following were available at 4, 12, 24 and 48 months: HRQoL (EQ-5D), mobility, ADL (Katz), function (Charnley); complications reported at 24 and 48 months: infection, DVT, pulmonary embolism, decubital ulcer, dislocations, acetabular malposition, periprosthetic fracture, non-union, myocardial infarction, pain, AVN, ADL; surgical outcomes: operating time, blood loss, blood transfusion, reduction **Outcomes relevant to the review:** mortality (at 24 and 48 months); unplanned return to theatre (re-operation) at 24 and 48 months; HRQoL (EQ-5D at 12 months)

Tidermark 2003 *(Continued)*

Notes	**Funding/sponsorship/declarations of interest:** grants from the Trugg-Hansa Insurance Company, Swedish Society for Medical Research, the Swedish Orthopaedic Association and the Stockholm County Council **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "the patients were randomly allocated (sealed-envelope technique)". No further details
Allocation concealment (selection bias)	Unclear risk	Study authors report use of sealed envelopes, but do not report if envelopes are sequentially numbered or opaque
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Although the number of surgeons is reported, study authors do not report whether surgeons are equally experienced with both types of implants
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Unclear whether participants were blind to allocation, but we assessed that this would not affect the completion of HRQoL outcomes
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were clearly reported with most owing to death
Other bias	Low risk	No other bias observed
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Van den Bekerom 2010

Study characteristics

Methods	RCT; parallel design **Review comparison group:** THA versus HA

Van den Bekerom 2010 *(Continued)*

Participants	**Total number of randomised participants:** 281 **Inclusion criteria:** displaced intracapsular femoral neck fractures, capability to give informed consent, no known metastatic disease, no contraindication to anaesthesia, ≥ 70 years of age; ability to understand written Dutch **Exclusion criteria:** inability to fulfil the inclusion criteria including refusal to consent, advanced radiological osteoarthritis or rheumatoid arthritis in the fractured hip; suspected pathological fracture; bedridden or barely mobile bed to chair; significant senile dementia **Setting:** multicentre; 7 district hospitals and 1 university hospital; Netherlands **Baseline characteristics** **Intervention group 1** (THA) • Age, mean (SD, range): 82.1 (± 6.3, 70.1 to 95.6) years • Gender, M/F, n: 25/90 • Comorbidities, cardiovascular/malignancies/pulmonary/neurological/locomotive/diabetes, n: 38/6/18/33/31/11 • Mobility without a stick, n: 64 • ASA status, I/II/III/IV/V/unknown: 11/48/44/10/0/2 • Preoperative waiting time, mean (range): 1 (0 to 9) days **Intervention group 2** (HA) • Age, mean (SD; range): 80.3 (± 6.2; 70.2 to 93.9) years • Gender, M/F, n: 22/115 • Comorbidities, cardiovascular/malignancies/pulmonary/neurological/locomotive/diabetes, n: 34/11/16/26/22/19 • Mobility without a stick, n: 85 • ASA status, I/II/III/IV/V/unknown: 19/77/33/5/0/3 • Preoperative waiting time, mean (range): 1 (0 to 10) days **Note:** • study authors did not report baseline characteristics for: smoking history, medication, BMI, place of residence, cognitive status, preoperative waiting time
Interventions	**General details:** all operations performed by experienced surgeons or residents under direct supervision of an experienced surgeon; participating surgeons used their own judgement to manage care (such as antibiotic and thromboembolic prophylaxis and surgical approach to the hip); type of anaesthesia reported by group (HA - spinal: 92; epidural: 5; general: 25; psoas block: 2; unknown: 13; THA - spinal: 71; epidural: 11; general: 30; psoas block: 0; unknown: 3); mobilised and full weight bearing as tolerated; use of patient education and physiotherapy supervision in ADL; after 6 weeks, allowed to mobilise without further restriction **Intervention group 1** • THA, cemented; 32 mm diameter modular head • Number randomised not clearly reported; overall 29 participants were excluded after randomisation because they did not meet the inclusion criteria or did not receive the prosthesis to which they were randomised; other losses within the group = 16 (owing to death; at 1 year); analysed for mortality = 115 **Intervention group 2** • HA, cemented, bipolar • Number randomised not clearly reported; overall 29 participants were excluded after randomisation because they did not meet the inclusion criteria or did not receive the prosthesis to which they were randomised; other losses within the group = 18 (owing to death; at 1 year); analysed for mortality = 137

Van den Bekerom 2010 *(Continued)*

	Note: • "Patients received either a hemiarthroplasty or a THR where one of two types of cemented femoral prostheses were implanted, a Weber Rotationsprosthese (Sulzer AG, Winterthur, Switzerland) or a Müller Geradschaft-prothese (Protek AG, Münsingen, Switzerland), either as a hemiarthroplasty or a THR" • unplanned return to theatre: reasons for re-operation were infection, acetabular wear and loosening; types of re-operation were not reported
Outcomes	**Outcomes measured/reported by study authors:** mortality (during hospital stay; at 12 months; at 5 years); length of hospital stay; functional status (modified HHS, pain using HHS, function using HHS; at 12 months, and at 5 years); revision surgery (at 5 years); dislocation (at 5 years); loosening of femoral component, loosening of acetabular; polythene wear; osteoarthritis at the acetabulum; protrusio acetabuli; fracture/fissure at the acetabulum; heterotopic ossification; complications (defined as general, and local) **Outcomes relevant to the review:** mortality (during hospital stay; at 12 months; at 5 years); unplanned return to theatre (revision surgery; at 12 months, 5 years, and 12 years) **Note:** • we used data at 5 year follow-up, as reported in the primary article • data for some outcomes were supplied by study authors during preparation of Parker 2010a.
Notes	**Funding/sponsorship/declarations of interest:** no funding **Study dates:** not reported **Note:** • also known as the ARTHRO study

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Low risk	Randomisation conducted externally
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Low risk	All operations performed by experienced surgeons and we assumed they were experienced with both implants in this study
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective

Van den Bekerom 2010 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Although the study authors report the total number randomised and overall number of losses, these numbers are not reported by group and we could not be certain whether losses were evenly balanced between groups
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Van Dortmont 2000

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF vs HA

Participants	**Total number of randomised participants:** 60
	
	Inclusion criteria: over 70 years of age; displaced (Garden's III or IV); diagnosed with 'senile dementia'
	
	Exclusion criteria: none reported
	
	Setting: single setting; hospital; Netherlands
	
	Baseline characteristics
	
	Intervention group 1 (IF)
	
	• Age, mean (range): 84 (72 to 92) years
	• Gender, M/F: 1/30
	• Comorbidities, type, n: neurological, 10; cardiovascular, 10; metabolic, 6; pulmonary, 2; rheumatoid, 0; malignancy, 4; other, 7
	• Cognitive status, dementia, mean CST-14 (range): 1.0 (0 to 5)
	• Place of residence:
	  ◦ psychogeriatric institutions, 17
	  ◦ old people's home, 11
	  ◦ own home, 3
	• ADL mean (IQR): 7.9 (7 to 9)
	
	Intervention group 2 (HA)
	
	• Age, mean (range): 84 (71 to 96) years
	• Gender, M/F: 7/22
	• Comorbidities, type, n: neurological, 7; cardiovascular, 6; metabolic, 5; pulmonary, 5; rheumatoid, 1; malignancy, 2; other, 6
	• Cognitive status, dementia, mean CST-14 (range): 1.1 (0 to 4)
	• Place of residence:
	  ◦ psychogeriatric institutions, 21
	  ◦ old people's home, 6
	  ◦ own home, 2
	• ADL mean (IQR): 6.7 (5 to 9)
	
	Overall:
	
	• Preoperative waiting time, median 1.0 days (IQR 1.0 to 2.0)

Van Dortmont 2000 *(Continued)*

	Note: • authors did not report: smoking history; medication; BMI; mobility; ASA status
Interventions	**General details:** routine follow up in patients' own environments at 4, 12 and 24 months; surgeons were staff or resident; spinal anaesthesia; prophylactic cefazolin as well as prophylactic thromboembolics; mobilisation out of bed on POD1 with unrestricted weight bearing **Intervention group 1:** • IF; three cannulated screws AO/ASIF; closed reduction on fracture table • Randomised = 31; analysed for outcomes at 4 and 12 months = 31 **Intervention group 2:** • HA; cemented Thompson, by anterior approach • Randomised = 29; analysed for outcomes at 4 and 12 months = 29 **Note:** • no details regarding: type of anaesthesia, pre- and postoperative care, rehabilitation
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 1, 4 and 12 months); loss of blood, operative duration; displacement; non-union; infection; mobility and destination; ADL; reoperation/secondary intervention **Outcomes relevant to the review:** mortality (at 4 and 12 months) **Note:** • mean follow-up time 16.5 months, range 0.17 to 69.5 • re-operation or secondary intervention reported, but not clearly, for each group
Notes	**Funding/sponsorship/declarations of interest:** conflicts of interest were not reported **Study dates:** April 1991 to January 1995

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomly allocated but no further details reported
Allocation concealment (selection bias)	Unclear risk	No details reported
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Although the number of surgeons is reported, study authors do not report whether surgeons are equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data

Van Dortmont 2000 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were clearly reported with most owing to death
Other bias	Low risk	No other bias observed
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Van Vugt 1993

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** IF versus HA
Participants	**Total number of randomised participants:** 43 **Inclusion criteria:** age range of 71 to 80 years; Garden's III or IV; "a very good degree of independence" **Exclusion criteria:** not reported **Setting:** single centre, hospital, the Netherlands **Baseline characteristics** **Intervention group 1** (IF) • Age, mean (SD): 75.3 (± 3) years • Gender, M/F: 10/11 • Comorbidities, type, n: associated ailments: 0 to 3, 15; > 3, 6 • Preoperative waiting time: < 24 hrs, 15; > 24 hrs, 6 • Fracture classification, Garden's III/IV: 7/14 **Intervention group 2** (HA) • Age, mean (SD): 76 (± 3) years • Gender, M/F: 8/14 • Comorbidities, type, n: associated ailments: 0 to 3, 15; > 3, 7 • Preoperative waiting time: < 24 hrs, 12; > 24 hrs, 10 • Fracture classification, Garden's III/IV: 8/14 **Note:** • authors did not report: smoking history, medication type, BMI, mobility, cognitive status, ASA status. Place of residence was not reported by group (42 of total participants lived independently)
Interventions	**General details:** no general details reported, follow-up took place at 3, 6, 12, 24 and 36 months **Intervention group 1:** • IF: DHS; closed reduction on a fracture table; full weight-bearing mobilisation starting the first post-operative day in patients with optimal reduction; otherwise under guidance from physiotherapist • Randomised = 21; 20 at 3 months (1 lost to follow-up), 18 at 12 months (2 died, 1 lost to follow-up), 16 at 36 months (5 died)

Van Vugt 1993 *(Continued)*

	Intervention group 2: • HA: bipolar (Stanmore variocup), cemented; full weight-bearing mobilisation starting the first post-operative day in patients with stable implant • Randomised = 22; 19 at 3 months (2 died, 1 lost to follow-up), 16 at 12 months (5 died, 1 lost to follow-up), 15 at 36 months (6 died, 1 lost to follow-up)
Outcomes	**Outcomes measured/reported by study authors:** mortality (available at 3, 6, 12, 24 and 36 months); adverse events within 36 month follow-up period: wound infection, non-union, AVN, loosening, fracture, cardiovascular, pulmonary infection, thromboembolic disease, cerebrovascular accident, psychiatric disease, urinary tract infection, bed sore; ADL (described as degree of independence); pain; hip mobility **Outcomes relevant to the review:** mortality (at 3, 12 and 36 months); unplanned return to theatre (described as cases with re-intervention; at 36 months)
Notes	**Funding/sponsorship/declarations of interest:** conflicts of interest were not reported **Study dates:** October 1985 to November 1987

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details of randomisation provided
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Although the number of surgeons is reported, study authors do not report whether surgeons are equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were clearly reported with most owing to death
Other bias	Low risk	No other bias observed
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration. It is not feasible to effectively assess risk of selective reporting bias without these documents

Vidovic 2013

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented vs uncemented
Participants	**Total number of randomised participants:** 79 **Inclusion criteria:** female; > 70 years of age; displaced femoral neck fracture (Garden's III or IV) **Exclusion criteria:** participants that could not comprehend the study protocol; patients with sustained pathological fracture; presence of local or systemic infection; hip osteoarthritis; complete pre-injury immobility; previous fracture of lower limbs; immunosuppression or other disease that interfere with bone metabolism **Setting:** hospital; single centre; Croatia **Baseline characteristics (overall)** • Age, mean (SD): 82.69 (± 4.48) years • BMI, mean (SD): 25.06 (± 4.04) kg/m^2 **Intervention group 1** (cemented) • Age, mean (SD): 82.9 (± 4.63) years • BMI, mean (SD): 24.62 (± 4.13) kg/m^2 **Intervention group 2** (uncemented) • Age, mean (SD): 82.04 (± 4.32) years • BMI, mean (SD): 25.5 (± 3.94) kg/m^2 **Note:** • study authors did not report baseline characteristics for: smoking history, medication, comorbidities, mobility assessment, place of residence, cognitive status, ASA status, preoperative waiting times
Interventions	**General details:** 5 surgeons skilled in hip replacement surgery with the assistance of surgical residents; carried out using direct lateral, Hardinge approach; protocols followed for anticoagulation, antibiotics, and anaesthesia for hip fracture (low-molecular-weight heparin-dalteparin 5000 IU once a day starting on POD1; 3 doses of cefazolin perioperatively; bupivacaine 0.5% and fentanyl for spinal and epidural anaesthesia); standard protocols for rehabilitation during hospitalisation followed by 21 days at rehabilitation centre; routine follow-up and scans were scheduled for 1, 6 and 12 months **Intervention group 1** • HA cemented; modular • Randomised = 38; analysed = 38 **Intervention group 2** • HA uncemented; modular Austin-Moore • Randomised = 41; analysed = 41 **Note:** • study authors did not report the following intervention details: time to mobilisation and weight bearing
Outcomes	**Outcomes measured/reported by study authors:** HHS (available at 3, 6 and 12 months); BMD; duration of surgery; length of hospital stay; complication rates (overall); mortality

Vidovic 2013 *(Continued)*

	Outcomes relevant to the review: mortality (12 months)
Notes	**Funding/sponsorship/declarations of interest:** funding not reported. Study authors declare no conflicts of interest **Study dates:** January 2007 to December 2010 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Watson 2013

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** screws versus fixed angle plate
Participants	**Total number of randomised participants:** 60 **Inclusion criteria:** > 50 years or age; minimally displaced subcapital intracapsular fractures; previously able to ambulate independently; no cognitive impairment **Exclusion criteria:** previous hip pain or femoral fracture; delirium or dementia; surgery > 72 hours after injury **Setting:** single centre; hospital; Australia **Baseline characteristics** **Intervention group 1** (screws) • Age, mean (range): 76.7 (53 to 93) years • Gender, M/F: 5/24 • Comorbidities, type: ischaemic heart disease/congestive cardiac failure/chronic obstructive airways disease, n: 2/1/1 • Use of walking aides, none/stick/frame, n: 20/5/4 • Place of residence, home/relatives/hostel/supported hostel, n: 8/20/0/1 **Intervention group 2** (DHS) • Age, mean (range): 77.9 (53 to 89) years • Gender, M/F: 6/25 • Comorbidities, type: ischaemic heart disease/congestive cardiac failure/chronic obstructive airways disease, n: 1/0/1 • Use of walking aides, none/stick/frame, n: 21/5/4 • Place of residence, home/relatives/hostel/supported hostel, n: 8/19/2/1 **Note:** study authors did not report baseline characteristics for the overall group, nor reported any baseline data for: smoking history, BMI, cognitive status, preoperative waiting time
Interventions	**General details:** number and experience of clinicians not reported; standard surgical technique; weight bearing as tolerated **Intervention group 1**

Watson 2013 *(Continued)*

- Screws - 3 partially threaded cannulated 6.5 mm titanium cancellous screws, in an inverted V configuration; type of screw is not specified
- Randomised = 29; losses for mortality and unplanned return to theatre = 1 (inadequate consent); losses at end of final follow-up = 13 (we noted inconsistencies between text and flow-chart and we could not be certain of exact numbers of losses and the reasons for loss); analysed for SF-12 = 19; analysed for other outcomes = 28

Intervention group 2

- DHS - 2-hole, with or without an anti-rotation screw
- Randomised = 31; losses for mortality and unplanned return to theatre = 1 (deemed unsuitable for internal fixation); losses at end of final follow-up = 19 (we noted inconsistencies between text and flow-chart and we could not be certain of exact numbers of losses and the reasons for loss); analysed for SF-12 = 23; analysed for other outcomes = 30

Outcomes

Outcomes measured/reported by study authors: mortality, revision, loss of fixation, surgical complications, WOMAC, Harris hip score, SF-12 (PCS and MCS). Follow-up for primary outcome (weeks): 6 weeks, 3 months, 6 months, 12 months and 24 months

Outcomes relevant to the review: mortality (24 months); unplanned return to theatre; HRQoL (SF-12, PCS - range of scores from 0 to 100 with higher scores indicating better quality of life; at 12 months)

Notes:

- although we contacted study authors for additional data (SDs) for continuous outcomes, we judged the median data to better represent the effect in the study population, accounting for the small study size and the possibility of not-normally distributed data. These data could not be used in the network meta-analysis which relied on mean values
- unplanned return to theatre: reasons for re-operation not reported; types of re-operation were replacement with arthroplasty

Notes

Funding/sponsor/declarations of interest: Victorian Orthopaedic Research Trust as partial funding; statistical position funding from educational grant from Synthes

Study dates: October 2004 to October 2010

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated block randomisation
Allocation concealment (selection bias)	Low risk	Sealed sequential envelopes
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors do not report the number of surgeons, their level of surgical experience, and whether they are experienced with both types of implants
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Unclear whether participants were blind to allocation, but we assessed that this would not affect the completion of HRQoL outcomes

Watson 2013 *(Continued)*

Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective
Incomplete outcome data (attrition bias) All outcomes	Low risk	Only 1 participant loss in each group for mortality and unplanned return to theatre, and we judged these outcomes to be at low risk of bias. For functional status and HRQoL, we noted more losses in the DHS group, and risk of attrition bias was high
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trial registration; it is not feasible to effectively assess risk of selective reporting bias without these documents

Wei 2020

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** 3 study arms; non-operative versus IF versus HA

Participants	**Total number of randomised participants:** 154
	
	Inclusion criteria: older than 75 years of age; Garden's I or II; mutual embedding and close combination of the fracture ends
	
	Exclusion criteria: pathological fracture; non-impacted or displaced fracture; avascular necrosis of femoral head; previous symptomatic hip pathology; infection; a history of fracture in the hip studied; deformity of lower limb
	
	Setting: single centre; hospital; China
	
	Baseline characteristics
	
	Intervention group 1 (non-operative)
	
	• Age, mean (SD): 83.48 (± 8.29) years
	• Gender, M/F: 14/37
	• Mobility assessment, walking without aid or just with one stick, n: 31
	• Cognitive status, with dementia, n: 8
	• ASA status, I/II/III/IV: 3/28/18/2
	• Preoperative waiting time, time to admission, mean (SD): 12.43 (± 10.16) hours
	• Preoperative waiting time, time to surgery, mean (SD): N/A
	• Additional information:
	  ○ BMD score, mean (SD): -4.35 (± 0.72)
	  ○ Prefracture HHS, mean (SD): 81.73 (± 14.86)
	  ○ Prefracture EQ-5D, mean (SD): 0.76 (± 0.21)
	  ○ Pain VAS no weight bearing, mean (SD): 1.71 (± 2.34)
	  ○ Pain VAS partial weight bearing, mean (SD): 6.19 (± 2.35)

Wei 2020 *(Continued)*

Intervention group 2 (IF)

- Age, mean (SD): 82.59 (± 9.33) years
- Gender, M/F: 13/38
- Mobility assessment, walking without aid or just with one stick, n: 28
- Cognitive status, with dementia, n: 11
- ASA status, I/II/III/IV: 5/29/16/1
- Preoperative waiting time, time to admission, mean (SD): 15.51 (± 8.98) hours
- Preoperative waiting time, time to surgery, mean (SD): 40.22 (± 23.67) hours
- Additional information:
  - BMD score, mean (SD): -4.51 (± 0.81)
  - Prefracture HHS, mean (SD): 84.25 (± 15.31)
  - Prefracture EQ-5D, mean (SD): 0.78 (± 0.23)
  - Pain VAS no weight bearing, mean (SD): 1.95 (± 2.16)
  - Pain VAS partial weight bearing, mean (SD): 6.04 (± 2.97)

Intervention group 3 (HA)

- Age, mean (SD): 82.02 (± 8.87) years
- Gender, M/F: 15/37
- Mobility assessment, walking without aid or just with one stick, n: 29
- Cognitive status, with dementia, n: 12
- ASA status, I/II/III/IV: 3/31/17/1
- Preoperative waiting time, time to admission, mean (SD): 11.85 (± 11.31) hours
- Preoperative waiting time, time to surgery, mean (SD): 38.59 (± 26.82) hours
- Additional information:
  - BMD score, mean (SD): -4.44 (± 0.69)
  - Prefracture HHS, mean (SD): 82.54 (± 16.07)
  - Prefracture EQ-5D, mean (SD): 0.75 (± 0.17)
  - Pain VAS no weight bearing, mean (SD): 1.78 (± 2.27)
  - Pain VAS partial weight bearing, mean (SD): 6.23 (± 2.88)

Note:

- Authors do not report: smoking history, medication, BMI, comorbidities, place of residence
- Prognostic variables are comparable between groups; authors performed statistical testing and none were significant

Interventions	**General details:** surgeries were performed by the same group of experienced orthopaedic trauma surgeons; groups 2 and 3 received perioperative antibiotics; all groups received low-molecular-weight heparin or rivaroxaban daily for 2 weeks; routine follow-up at 1, 3, 6, 12, 24 and 36 months **Intervention group 1:** • non-operative treatments: patients were required to lie in bed for at least 2 weeks; semisupine position and elevation of the head were adopted to ensure even weight distribution; instructed to turn from side to side in bed regularly; 1 pillow was placed horizontally on the bed under the patient's calves; recumbent bed exercises and breathing exercises; physicians from rehabilitation, geriatrics and orthopaedics departments were involved in care • Randomised = 51; 45 at 3 months (5 died, 1 lost to follow-up), 39 at 12 months (12 died, 0 lost to follow-up), 26 at 36 months (24 died, 1 lost to follow-up) **Intervention group 2:** • IF: three cannulated screws percutaneously; weight bearing after two weeks of bed rest; semisupine position and elevation of the head were adopted to ensure even weight distribution; instructed to turn from side to side in bed regularly; one pillow was placed horizontally on the bed under the patient's

Wei 2020 *(Continued)*

calves; recumbent bed exercises and breathing exercises; physicians from rehabilitation, geriatrics and orthopaedics departments were involved in care
- Randomised = 51; 44 at 3 months (7 died, 0 lost to follow-up), 36 at 12 months (13 died, 2 lost to follow-up), 24 at 36 months (26 died, 1 lost to follow-up)

Intervention group 3:

- HA: bipolar uncemented prosthesis; direct lateral approach; walking with a frame from 2 days post surgery
- Randomised = 52; 43 at 3 months (8 died, 1 lost to follow-up), 37 at 12 months (14 died, 1 lost to follow-up), 24 at 36 months (25 died, 3 lost to follow-up)

Outcomes	**Outcomes measured/reported by study authors:** HHS; EQ-5D; pain (VAS); mortality (all at 1, 3, 6, 12, 24 and 36 months); adverse events within 36 month follow-up period: non-union, AVN, infection, periprosthetic fracture, DVT, pulmonary infection, unplanned return to theatre; operative duration; blood loss; length of hospital stay; debridement **Outcomes relevant to the review:** mortality (at 3, 12 and 36 months); HRQoL using EQ-5D (at 3 and 12 months); unplanned return to theatre (during 36 month follow-up)
Notes	**Funding/sponsorship/declarations of interest:** funding not reported. Study authors declare no competing interests **Study dates:** January 2010 to October 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "allocated using block randomization by means of computer-generated random number sequence"
Allocation concealment (selection bias)	Low risk	Quote: "concealed in sequentially numbered, opaque, sealed envelopes until randomization"
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Study authors report that the interventions were performed by experienced surgeons but we could not be certain whether surgeons were equally experienced in using the study implants
Blinding of outcome assessment (detection bias): HRQoL	Low risk	Unclear whether participants were blind to allocation, but we assessed that this would not affect the completion of HRQoL outcomes
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data
Blinding of outcome assessment (detection bias): unplanned return to theatre	High risk	It is not possible to blind surgeons to treatment groups. We expected surgeons were likely to assess this outcome, and decisions to re-operate could be subjective

Wei 2020 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Most losses were owing to death, which is expected in this population. Few participants were lost to follow-up and these losses were relatively balanced between groups
Other bias	Low risk	We identified no other sources of bias
Selective reporting (reporting bias)	Unclear risk	Study is retrospectively registered with a clinical trials register (NCT04219943; first received 7 January 2020). It is not feasible to use these clinical trials documents to effectively assess risk of selective reporting bias

Wihlborg 1990

Study characteristics	
Methods	RCT; single centre; parallel design **Review comparison group:** smooth pin versus smooth pin
Participants	**Total number of randomised participants:** 200 **Inclusion criteria:** femoral neck fractures; displaced and non-displaced **Exclusion criteria:** not reported **Setting:** single centre; hospital; Sweden **Baseline characteristics** **Intervention group 1** (Rydell nail; data only for analysed participants) • Age, median (range): 78 (46 to 94) years • Gender, M/F: 28/50 • Fracture classification, undisplaced/displaced: 12/66 **Intervention group 2** (Gouffon pins; data only for analysed participants) • Age, median (range): 76 (49 to 100) years • Gender, M/F: 30/50 • Fracture classification, undisplaced/displaced: 15/65 **Note:** • study authors did not report baseline characteristics for the overall group, nor did they report any baseline data for: smoking history, BMI, mobility assessment, place of residence, cognitive status, preoperative waiting time
Interventions	**General details:** 7 surgeons: 4 in nail group, 3 in pin group; "ample experience"; traction applied to displaced fractures; closed reduction on extension table; general or spinal anaesthetic; mobilisation the day after surgery with immediate weight bearing; majority operated on within 24 hours **Intervention group 1** • Four-flanged Rydell nail, predrilled channel • Randomised = 100 **Intervention group 2** • Three Gouffon pins, flanges prepared with a punch, no predrilling, threaded for 2.5 cm from the tip • Randomised = 100

Wihlborg 1990 *(Continued)*

	Note: • 42 died with "no complications"; 158 followed for two years until re-displacement, non-union or late segmental collapse
Outcomes	**Outcomes measured/reported by study authors:** mortality; failure; removal of fixed device; non-union, segmental collapse (24 months) **Outcomes relevant to the review:** mortality (12 months) **Note:** • we did not report data for unplanned return to theatre, because we could not confirm number of participants for which data were available
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** September 1984 to November 1987 **Note:** • we did not complete risk of bias assessment because the intervention characteristics meant that we were unable to include this study within a network

Xu 2017

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA versus HA
Participants	**Total number of randomised participants:** 76 **Inclusion criteria:** neglected femoral neck fracture (defined as > 30 days after injury); ≥ 60 years of age; able to walk without aids before injury; able to provide informed consent **Exclusion criteria:** refusal to undergo surgery; any contraindication to surgery or anaesthesia; chronic hip pain and imaging revealing osteoarthritis or atrophic arthritis; metastatic cancer; active inflammatory disease **Setting:** hospital; single centre; China **Baseline characteristics** **Intervention group 1** (THA) • Age, mean (SD): 76.16 (± 6.53) years • Gender, M/F: 16/22 • Current smokers, n: 11 • Comorbidities (diabetes, hypertension, coronary heart disease, cerebral infarction, chronic bronchitis), n. 0: 6; 1: 14; 2: 16; 3: 2; > 3: 0 • Preoperative waiting time, mean (SD): 46.05 (± 11.17) days **Intervention group 2** (HA) • Age, mean (SD): 75.45 (± 6.52) years • Gender, M/F: 11/27 • Current smokers, n: 9

Xu 2017 *(Continued)*

	• Comorbidities (diabetes, hypertension, coronary heart disease, cerebral infarction, chronic bronchitis), n. 0: 4; 1: 12; 2: 17; 3: 4; > 3: 1 • Preoperative waiting time, mean (SD): 45.95 (± 10.17) days **Note:** • Study authors did not report baseline characteristics for: medication, BMI, place of residence, cognitive status, ASA status; fracture classification
Interventions	**General details:** 1 experienced chief orthopaedic surgeon specialising in hip joint surgery; performed with spinal anaesthesia (or spinal and epidural, for THA); prophylactic antibiotics and antithromboembolics given; functional exercises started on day of surgery, plan for full weight bearing 6 weeks after surgery; routine follow-up annually (1 to 5 years) **Intervention group 1** • THA; uncemented prosthesis produced by Johnson & Johnson (USA), Aesculap (Germany), or Irene (Tianjin, China) • Randomised = 38; no reported losses; analysed = 38 **Intervention group 2** • HA bipolar; uncemented prosthesis produced by Johnson & Johnson (USA), Aesculap (Germany), or Irene (Tianjin, China) • Randomised = 38; no reported losses; analysed = 38
Outcomes	**Outcomes measured/reported by study authors:** intraoperative blood loss, operation time, duration of hospital stay, postoperative length discrepancy in lower extremities, HHS (before surgery; 1 year and 5 year postoperatively), complications (deep infection, prosthetic loosening, dislocation, periprosthetic fracture, acetabular osteoarthritis, all-cause mortality (5 years) **Outcomes relevant to the review:** mortality (5 years)
Notes	**Funding/sponsorship/declarations of interest:** funding not reported; study authors declare no conflicts of interest **Study dates:** June 2000 to November 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Low risk	Independent statistician prepared sequential sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	Low risk	It is not possible to blind surgeons to treatment groups but we did not expect that lack of blinding would influence performance
Other performance bias: surgeon experience of both implants	Unclear risk	Although the number of surgeons is reported, study authors do not report whether surgeons are equally experienced with both types of implants
Blinding of outcome assessment (detection bias): mortality	Low risk	We did not expect that lack of blinding of assessors of objective measures would influence objective outcome data

Xu 2017 *(Continued)*

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

ADL: activities of daily living; **AHS**: manufacturers name for implant; **AMBI:** manfacturer's name for implant; **AMT:** abbreviated mental test; **AMTS**: Abbreviated Mental Test Score; **AO**: Arbeitsgemeinschaft für Osteosynthesefragen (system for classification of fractures); **ASA**: American Society of Anesthesiologists; **AVN**: avascular necrosis; **BI**: Barthel Index; **BMD**: bone mineral density; **BMI**: body mass index; **CI**: cerebral infarction; **CCI**: Charlson Comorbidity Index; **COAD**: chronic obstructive airways disease; **CPCS**: collarless, polished, cemented stem; **CPT**: collarless, polished, double-taper design concept; **CRF:** chronic renal failure; **CST**: cognitive screening test; **CT**: chromatography; **CTU**: Clinical Trials Unit; **CVA**: cerebrovascular accident; **DB**: manufacturers name for implant; **DHS:** dynamic hip screw; **DM**: dual-mobility; **DSM-5**: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition; **DVT**: deep vein thrombosis; **EQ-5D**: EuroQol Quality of Life - 5 dimensions; **ETS**: Exeter trauma stem; **GARS**: Groningen Activity Restriction Scale;**GI**: gastrointestinal; **HA**: hemiarthroplasty; **HAC**: hydroxyapatite-coated; **HHS**: Harris Hip Score; **HRQoL**: health-related quality of life; **IADL**: instrumental activities of daily living; **ICEPAP-O**: icepop capability measure for older people; **IF:** internal fixation; **IHD**: ischaemic heart disease; **IQR**: interquartile range; **ISS**: Injury Severity Score; **ITT**: intention-to-treat;**IU**: international units; **IV**: intravenous(ly); **LD/Fx**: manufacturers name for implant; **LIH:** Lars Ingvar Hansson; **M/F**: male/female; **MI**: myocardial infarction; **MMSE**: Mini-Mental State Examination; **MRI**: magnetic resonance imaging; **MTPM:** maximal total point motion; **NICE**: National Institute for Health and Care Excellence; **NMS**: New Mobility Score; **NSAID:** non-steroidal anti-inflammatory drug; **OGEE**: manufacturers name for implant; **OHS**: Oxford Hip Score; **OTA**: orthopaedic trauma association; **PADL**: physical activities of daily living; **POD**: postoperative day; **PRBC**: packed red blood cells; **PCU**: polycarbonate–urethane; **QoL**: quality of life; **RCT**: randomised controlled trial; **SD**: standard deviation; **SF-36/12(PCS or MCS)**: Short-Form General Health Survey -36/12 (physical component score or mental component score); **SMFA**: Short Musculoskeletal Function Assessment; **6MWT**: six-minute walk test; **SPMSQ**: Short Portable Mental Status Questionnaire; **TFN:** Targon Femoral Neck; **THA**: total hip arthroplasty; **TIA**: transient ischaemic attack; **TUG**: Timed Up and Go; **UCLA**: University of California, Los Angeles; **UHR**: universal head system (manufacturer name); **UTI**: urinary tract infection; **VAS**: visual analogue scale; **VELCA**: Verona Elderly Care Study; **vs:** versus; **WOMAC**: Western Ontario and McMaster Universities Osteoarthritis Index

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

Study	Reason for exclusion
Aydin 2009	RCT, comparing distal and proximal centralising devices for arthroplasty. We excluded this study because it investigated surgical approaches rather than implants, and the interventions were therefore ineligible.
Bisaccia 2018	Study comparing cannulated screws with DHS plus an antirotational screw for femoral neck fractures. We noted a large difference between the numbers of participants in each study group. Whilst the study report stated that participants were randomised into groups, we also noted that it was described as a retrospective case series. We excluded the study because we expected that it was not randomised.
Dong 2019	Non-randomised study comparing cancellous screws and cannulated screws, excluded on study design.
FAITH-2 2020	RCT, comparing screws with sliding hip screws in young femoral neck fracture patients. We excluded the study because the mean age of participants was 41 (range 21 to 60) years, and the study investigators intentionally recruited younger participants that were not in our expected population.
ISRCTN42349821	RCT, comparing Thompsons HA with Exeter Trauma Stem. Abandoned due to lack of funding

Study	Reason for exclusion
Jensen 1984	RCT; internal fixation (4 AO screws) vs uncemented Thompson Moore prosthesis. This study was reported only as an abstract publication with insufficient detail and no useable outcome data.
Karpman 1992	RCT, comparing Austin Moore with cemented and uncemented bipolar hemiarthroplasty. We excluded this study because it was published only as an abstract with limited detail, and it did not report the number of participants randomised to each group.
Kavcic 2006	RCT, comparing THA and HA. We excluded this study because it was published only as an abstract with limited detail, and it did not report the number of participants randomised to each group.
Kumar 2015	RCT, comparing multiple cancellous screws with and without fibular graft in young adults. We excluded this study because the mean age of participants was 41.1 (± 12.2) years of age. We expected that participants would be below 60 years of age and therefore not in our expected population.
Min 1999	RCT, comparing dynamic hip screws with cannulated screws. We excluded the study because the mean age of participants for the screw group was 45 years (range 17 to 69) and the plate group was 47 years (range 18 to 91). We decided that a high proportion of participants would be representative of younger populations and the older participants could not be separated for the purposes of the analysis.
Okcu 2015	RCT, comparing screws with full or partial threads. We excluded the study because the mean age of participants in the two groups were 41.5 (SD ±13.9) and 42.7 (SD ±12.9), and therefore a low proportion of participants would be in our expected population.
Qiu 2016	RCT, comparing smooth pins with cancellous screws for use with a proximal femoral locking plate in participants undergoing hip fracture surgery. We excluded the study because the participants' ages ranged from 35 to 42 years of age, and therefore they were not representative of our expected population .
Rosen 1992	RCT, comparing bipolar versus unipolar hemiarthroplasty in displaced subcapital fractures of the hip in an elderly population. We excluded this study because it was published only as an abstract with insufficient information on numbers of participants in each group and insufficient quantitative outcome data.
Sernbo 1986	RCT comparing cannulated screws with a Rydell four-flanged nail. The study report was available only as an abstract, with insufficient information to justify inclusion. The numbers of participants in each group were not reported and no useable outcome data were available.
Siavashi 2015	RCT comparing dynamic hip screw with cannulated screw in adults 18 to 60 years of age. The average age of participants in the cannulated screw group was 28 (range 18 to 58) years and in the DHS group was 30 (range 18 to 60) years. We excluded this study because it was not representative of our expected population.
Somashekar 2013	Study comparing unipolar with bipolar hemiarthroplasty in adults > 60 years of age. We judged that this study was not randomised because study authors described the use of purposive sampling to select participants.
Sorensen 1996	RCT comparing dynamic hip screw with hook-pins. The study report was available only as an abstract, with insufficient information to justify inclusion. The only reported outcome is "registered complications" which is not relevant to our review.
Stock 1997	RCT, comparing ceramic arthroplasty with Thomson's hemiarthroplasty. We excluded this study because it was published only as an abstract with limited detail and it did not report the number of participants randomised to each group.
Van Thiel 1988	RCT, comparing a Moore and Bateman bipolar prosthesis. We excluded this study because it was published only as an abstract with insufficient detail and no quantitative outcome data.

Study	Reason for exclusion
Yin 2016	RCT, comparing screws with compression plates in adults aged 16 to 64 years. We excluded the study based on the mean participant age being 47.5 years for group A and 48.6 years for group B, and therefore not representative of our expected population.
Yu 2013	RCT, comparing multiple cancellous screws with and without vascularised iliac graft in young adults. We excluded the study because all participants were < 40 years of age, and therefore not in our expected population.

AO: Arbeitsgemeinschaft für Osteosynthesefragen (system for classification of fractures); **DHS**: dynamic hip screw; **HA**: hemiarthroplasty; **RCT**: randomised controlled trial; **SD:** standard deviation; **THA**: total hip arthroplasty

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

NCT00800124

Methods	RCT, parallel group Comparison: HA (cemented) versus HA (modern uncemented)
Participants	**Number of recruited participants**: 334 **Inclusion criteria**: people aged > 70 years with a Garden's III or IV acute hip fracture **Exclusion criteria**: person or relative refuse enrolment **Settings**: hospital, Norway
Interventions	HA: cemented Landos prosthesis HA: modern uncemented Landos prosthesis
Outcomes	Mortality (1 year)
Notes	Study completed June 2011

NCT00859378

Methods	RCT, parallel group Comparison: HA (modern uncemented) versus HA (cemented)
Participants	**Number of expected participants:** 400 **Inclusion criteria:** proximal femoral fracture **Exclusion criteria:** rheumatoid arthritis, pathologic fracture, severe dementia (preventing informed consent) **Setting:** Finland
Interventions	Cemented semi-endoprosthesis (Basis, Smith & Nephew) Uncemented semi-endoprosthesis (Biomet Taperloc, Biomet Inc.)
Outcomes	Mortality (3 months); prosthetic complications (1 year)

NCT00859378 *(Continued)*

Notes	Active, not recruiting; last updated 7 April 2015

NCT01432691

Methods	RCT, parallel group Comparison: THA versus HA
Participants	**Number of participants**: 70 **Inclusion criteria**: people aged > 70 years, admitted to hip fracture department with a Garden's III to IV femoral neck fracture or a fracture Garden's I to II with over 20-degree posterior tilt, with a preoperative New Mobility Score ≥ 6, ASA score ≤ III, are able to give informed consent, be cognitively intact (Hindsøe score ≥ 6) and speak and understand Danish **Exclusion criteria**: none **Settings**: hospital, Denmark
Interventions	THA: BFX (Biomet CE-number: 00520) HA: hemialloplastik
Outcomes	Migration/rotation (RSA); function (WOMAC); HRQoL (EQ-5D)
Notes	Study completed in June 2015

NTR1782

Methods	RCT, parallel design Comparison group HA (cemented) vs HA (modern uncemented)
Participants	**Number of expected participants:** 400 **Inclusion criteria:** people aged > 65 years of age with a proximal intracapsular femoral fracture who should be treated with a hemiarthroplasty. **Exclusion criteria:** multiple trauma patient, pathological fracture, symptomatic, coxarthritis at the ipsilateral side, osteosynthesis revision. **Setting:** Netherlands
Interventions	HA (cemented stem) vs HA (modern, hydroxyapatite coated uncemented stem)
Outcomes	Composite endpoint of serious adverse events; post-surgery delirium; surgical time; radiological evaluation; pain; complications and mobilisation. Follow-up: 0 to 30 days (serious adverse events), 6 weeks, 12 weeks and 1 year
Notes	Study completed 30 June 2012 but no trial report available

ASA: American Society of Anesthesiologists; **EQ-5D:** EuroQol Quality of Life - 5 dimensions; **HA:** hemiarthroplasty; **HRQoL:** health-related quality of life; **PFNA:** proximal femoral nail antirotation; **RCT:** randomised controlled trial; **RSA:** radiostereometric analysis; **THA:** total hip arthroplasty; **WOMAC:** Western Ontario and McMaster Osteoarthritis index

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

ChiCTR1800015159

Study name	Four cannulated screw internal fixation in treatment of young and middle-aged displaced femoral neck fractures: a prospective randomised study
Methods	RCT; parallel design **Review comparison group:** screw versus screw
Participants	**Estimated number of participants:** 60 **Inclusion criteria:** displaced femoral neck fractures that are diagnosed by CT and X-ray; Garden's III to IV; 18 to 65 years of age; males or females; history of injury **Exclusion criteria:** pathological fractures; fracture with tumour, immunodeficiency disease, spinal cord injury or nerve injury; refusal to sign informed consent **Setting:** Third Hospital of Hebei Medical University, China
Interventions	4 cannulated screw internal fixation versus 3 cannulated screw internal fixation
Outcomes	HHS; VAS; incidence of adverse reactions after surgery; fracture healing time
Starting date	Date of first enrolment: 3 December 2018
Contact information	Study leader: Pengcheng Wang Email: pengchengwang999@163.com Location: Third Hospital of Hebei Medical University, Shijiazhuang, Hebei, China
Notes	

ChiCTR1800015618

Study name	A prospective randomised controlled trial of novel anatomical femoral neck plates for treating femoral neck fractures
Methods	RCT; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Estimated number of participants:** 60 **Inclusion criteria:** displaced femoral neck fractures that are diagnosed by CT and X-ray; > 18 years of age; males or females; have a history of injury **Exclusion criteria:** pathological fractures; fracture with tumour, immunodeficiency disease, spinal cord injury or nerve injury; refusal to sign informed consent **Setting:** General Hospital of PLA, China
Interventions	Femoral neck plate fixation versus 3 cannulated screws
Outcomes	Fracture healing time; HHS; the incidence of adverse reactions after surgery; VAS; non-union; neck angle; time to full weight bearing; length of femoral neck
Starting date	Date of first enrolment: 4 April 2018
Contact information	Study leader: Peifu Tang Email: pftang301@126.com

ChiCTR1800015618 *(Continued)*

	Location: Orthopedics Department, General Hospital of PLA, Haidian District, Beijing, China
Notes	

ChiCTR1800019531

Study name	A randomised controlled trial for comparing the hemiarthroplasty with the total hip arthroplasty in the treatment of femoral neck fractures in patients older than 75 years
Methods	RCT, parallel group Comparison: THA versus HA
Participants	**Estimated number of participants**:100 **Inclusion criteria**: people who are willing to participate in this study with a displaced femoral neck fracture, diagnosed by CT or X-ray, aged > 75 years with a history of injury **Exclusion criteria**: pathological fractures; fracture with tumour or immunodeficiency disease; fracture with spinal cord injury or nerve injury, refusal to sign informed consent **Settings**: hospital, China
Interventions	THA (unspecified) HA (unspecified)
Outcomes	Total blood loss; maximum haemoglobin decline; blood transfusion rate; pain score (VAS); range of hip flexion and abduction; length of stay; postoperative compliance; function (HHS & WOMAC); incidence of thrombosis
Starting date	2 November 2018
Contact information	Zha Guo-chun, 41049015@qq.com, Affiliated Hospital of Xuzhou Medical University, China.
Notes	

ChiCTR1900022697

Study name	Treatment of femoral neck fracture by axial compressing and lateral supporting screws: a randomised controlled trial
Methods	RCT; parallel design **Review comparison group:** screw versus fixed angle plate
Participants	**Estimated number of participants:** 64 **Inclusion criteria:** having a history of injury; femoral neck fractures that are diagnosed by CT and X-ray; > 16 years of age; signed the informed consent form **Exclusion criteria:** metabolic osteopathy or pathological fracture; lower extremity deformity before fracture; nerve injury such as spinal cord affecting lower extremity function; participants unable to cooperate with researchers **Setting:** Fuzhou Second Hospital Affiliated to Xiamen University, China

ChiCTR1900022697 *(Continued)*

Interventions	Fixation by axial compressing and lateral supporting screws versus fixation by parallel screws
Outcomes	Fracture healing situation; femoral neck length; HHS; osteonecrosis of femoral head
Starting date	Date of first enrolment: 1 May 2019
Contact information	Study leader: Yanbin Lin Email: 13860603823@139.com Location: Fuzhou Second Hospital Affiliated to Xiamen University, Cangshan District, Fuzhou, Fujian
Notes	

ISRCTN15606075

Study name	WHiTE 8 COPAL: a randomised controlled trial of low dose single antibiotic loaded cement versus high dose dual antibiotic loaded cement in patients receiving a hip hemiarthroplasty after fracture
Methods	RCT, parallel group Comparison: HA (modern, cemented) versus HA (modern, cemented)
Participants	**Estimated number of participants**: 4920 **Inclusion criteria**: people aged > 60 years with an intracapsular hip fracture, which in the opinion of the treating surgeon requires acute surgical treatment with a cemented hip hemiarthroplasty **Exclusion criteria**: people will be excluded if they are allergic to gentamicin or clindamycin **Settings**: hospital, multicentre, UK
Interventions	HA: cemented hemiarthroplasty with low dose single antibiotic cement with choice of femoral head and stem. Cement used will be Heraeus Palacos R+G cement (Hanau, Germany) – contains gentamicin 0.5 g per 40 g mix of cement HA: cemented hemiarthroplasty with high dose dual antibiotic cement with choice of femoral head and stem. Cement used will be Heraeus Copal G+C cement (Hanau, Germany) – contains gentamicin 1 g and clindamycin 1 g per 40 g mix of cement.
Outcomes	Deep infection (CDC definition); mortality; HRQoL (EQ-5D-5L); complications; antibiotic use; resource use; mobility; residential status
Starting date	15 December 2017
Contact information	Stephanie Wallis, white8-copal@ndorms.ox.ac.uk
Notes	

ISRCTN28566489

Study name	An investigation in people aged 60 years and over with a hip fracture to determine whether fixing the broken hip bone or replacing the hip joint gives the patient a better quality of life after 4 months
Methods	RCT, parallel design

ISRCTN28566489 *(Continued)*

	Review comparison group: internal fixation (SHS or cannulated screws) versus arthroplasty (HA or THA)
Participants	**Estimated number of participants:** 878 **Inclusion criteria:** ≥ 60 years of age, presenting to a study recruitment centre for treatment of hip fracture; minimally displaced intracapsular hip fracture that in the opinion of the treating surgeon may benefit from surgical treatment **Exclusion criteria:** fracture only apparent on cross-sectional imaging; in the opinion of the treating surgeon, the fractures cannot be fixed without a reduction manoeuvre; fracture complicated by local tumour deposits; clinically relevant pre-existing osteoarthritis of the ipsilateral hip joint **Setting:** 12 hospitals; UK
Interventions	Internal fixation (SHS or cannulated screws) versus arthroplasty (HA or THA)
Outcomes	HRQoL (EQ-5D-5L); mobility (subjective and objective measure); residential status; mortality; complications; resource use; pain
Starting date	Recruitment start date: 10 June 2021
Contact information	Prof Matthew Costa (matthew.costa@mdorms.ox.ac.uk) and Prof Xavier Griffin (x.griffin@qmul.ac.uk)
Notes	

Kalsbeek 2020

Study name	Study protocol for the DEFENDD trial: an RCT on the Dynamic Locking Blade Plate (DLBP) versus the Dynamic Hip Screw (DHS) for displaced femoral neck fractures in patients 65 years and younger
Methods	RCT; parallel design **Review comparison group:** fixed angle plate vs fixed angle plate
Participants	**Estimated number of participants:** 266 **Inclusion criteria:** 18 to 65 years of age with a displaced femoral neck fracture, Garden's type III or IV **Exclusion criteria:** pathological fracture, ipsilateral or contralateral fracture of the lower extremity, ISS ≥ 16; local infection or inflammation at time of operation; symptomatic arthritis or osteoarthritis; previous surgery of the ipsilateral hip; open fracture; morbid obesity; wheelchair-bound pre-injury; admitted to a nursing home pre-injury; not mentally competent **Setting:** 6 trauma centres in the Netherlands
Interventions	DLBP versus DHS
Outcomes	Revision surgery due to non-union, AVN, or cut out; AVN; non-union; implant-related complications; postoperative complications; rate of elective removal after union; operation time; baseline parameters; costs; HRQoL
Starting date	Date of first enrolment: 1 October 2018
Contact information	Study leader: Jorn Kalsbeek Email: jorn.kalsbeek@gmail.com

Kalsbeek 2020 *(Continued)*

	Location: Deventer Hospital, Deventer, Netherlands
Notes	

NCT01109862

Study name	Prospective randomised comparison of bipolar hemiarthroplasty and total hip arthroplasty with large femoral heads for the treatment of displaced intracapsular femoral neck fractures in the elderly
Methods	RCT, parallel group Comparison: HA (bipolar, cemented) versus THA (large head, cemented)
Participants	**Estimated number of participants**: 80 **Inclusion criteria:** people aged from 70 to 90 years, with an acute femoral neck fracture, independent community ambulator (more than 0.5 km, without the aid of another person, use of a cane is permitted) and an abbreviated mental test score > 6 **Exclusion criteria:** pathological fracture (excluding osteoporosis), rheumatoid arthritis, symptomatic arthrosis of the involved hip, neurological disorder that may significantly influence walking ability and/or tendency to dislocate, chronic corticosteroid use, concomitant other fracture or very high surgical risk **Settings**: hospitals, multicentre, UK
Interventions	All cemented THA Cemented bipolar HA
Outcomes	Function (OHS); HRQoL (SF-36); dislocation risk; mortality. Follow-up: 2 years
Starting date	April 2010
Contact information	Dror Lakstein, drorale@gmail.com
Notes	Recruiting

NCT01578408

Study name	Corail-SP study - a prospective randomised comparison between cemented and uncemented hydroxyapatite coated prosthesis stems in total hip arthroplasty in patients with femoral neck fractures
Methods	RCT, parallel group Comparison THA (cemented) versus THA (modern uncemented)
Participants	**Estimated number of participants:** 109 **Inclusion criteria:** people approximately 60 to 85 years of age, who are acutely admitted to Mölndal's Hospital with a dislocated intracapsular femoral neck fracture, that in clinical practice is treated with a hip prosthesis operation, and who live independently

NCT01578408 *(Continued)*

	Exclusion criteria: people who have difficulties in understanding the intent of the study, have rheumatic disorders (RA, Bechterew, SLE), current cortisone treatment, stroke with remaining weakness or neurological disorders with affection of locomotion, dementia, grave obesity with BMI ≥ 30 to 35 kg/m^2 or a delay between time of injury and time of surgery exceeding 72 hours **Setting:** Sweden
Interventions	Surgery with a reverse hybrid arthroplasty with an uncemented hydroxyapatite coated Corail stem and a cemented Marathon cup (DePuy) Surgery with a totally cemented option with a Lubinus SPII stem and a IP cup (Link)
Outcomes	Time to mobilisation (days); cognitive status (SPMSQ); intraoperative partial pressure oxygen with a pulmonary catheter; bone remodelling (hip DEXA); inflammatory response (blood samples); fixation / migration / loosening of the hip prosthesis components (RSA) and conventional pelvis and hip X-ray exams; re-operation; HRQoL (EQ-5D); activity level (UCLA); function (HHS). Follow-up visits at 3 and 6 months, 1, 2, 5, 7 and 10 years
Starting date	11 May 2010
Contact information	Johan Kärrholm, Orthopaedic Department, Sahlgrenska University Hospital, Gothenburg, Sweden
Notes	

NCT01787929

Study name	Cemented versus uncemented hemiarthroplasty for displaced femoral neck fracture in elderly patients: a randomised prospective trial
Methods	RCT, parallel group Comparison: HA (cemented) versus HA (uncemented)
Participants	**Estimated number of participants**: 150 **Inclusion criteria**: people aged > 70 years with displaced femoral neck fractures (Garden's III and IV), ASA score ≤ III, Lee score ≤ 2 **Exclusion criteria**: Parker score < 4, pathological femoral neck fracture (Paget disease or tumour) **Settings**: hospital, France
Interventions	HA (cemented): hemiarthroplasty surgery with cement for displaced femoral neck fractures HA (uncemented): hemiarthroplasty surgery without cement is a surgery for displaced femoral neck fractures
Outcomes	Function (HHS) at 3 and 12 months
Starting date	7 February 2016, expected primary outcome completion 7 February 2018
Contact information	bernard-de-dompsure.r@chu-nice.fr
Notes	

NCT02699619

Study name	Undisplaced femoral neck fractures 2 Hansson pins or 3 pins interlocked in plate (Pinloc) using RSA
Methods	RCT; parallel design Single centre; Norway
Participants	**Estimated number of participants**: 30 **Inclusion criteria:** undisplaced femoral neck fractures; able to walk independently, aids such as crutches or walker allowed; able to consent; fit for surgery with pins with or without plate **Exclusion criteria:** not willing or able to attend follow-up; previous fracture or surgery with retained metal work in the same hip; concomitant disease that will shorten life expectancy (i.e. cancer, COPD)
Interventions	Hannson pins vs Pinloc
Outcomes	Change fracture displacement during healing; perioperative blood loss; time of surgery; EQ-5D; time to union; HHS; postoperative pain; TUG; satisfaction with operation; motion during healing; re-operation; mortality (12 months)
Starting date	March 2016
Contact information	Frede Frihagen, Oslo University Hospital, Norway
Notes	

NCT02996383

Study name	Fixation versus arthroplasty for undisplaced intracapsular fractures
Methods	RCT; parallel design Single centre; UK
Participants	**Estimated number of participants**: 50 **Inclusion criteria:** undisplaced intracapsular fracture; to include those who lack capacity (e.g. dementia) if consent from next of kin is provided **Exclusion criteria:** lack of consent; principal investigator (surgeon) is unavailable to supervise treatment; pathological fractures; delayed presentation who could be treated conservatively; unfit for either surgical procedure; younger patients, less than 80 years who are independently mobile and very active will be excluded from internal fixation
Interventions	Internal fixation using Targon femoral nail vs cemented hemiarthroplasty
Outcomes	Mobility
Starting date	May 2016
Contact information	MJ Parker: Peterborough and Stamford Hospitals NHS Foundation Trust
Notes	

NCT04075461

Study name	Arthroplasty versus internal fixation for undisplaced femoral neck fracture (SENSE)
Methods	RCT; parallel design Multicentre; Denmark
Participants	**Estimated number of participants:** 330 **Inclusion criteria:** ≥ 65 years old; undisplaced femoral neck fracture; posterior tilt less than 20 degrees; New Mobility Score ≥ 5 (indicating ability to walk); cognitively intact in order to achieve informed consent **Exclusion criteria:** pathological fractures; does not speak Danish
Interventions	Arthoplasty vs internal fixation (no additional details)
Outcomes	Mobility; EQ-5DL; OHS; re-operation; mortality (1 year); pain; Barthel-20
Starting date	1 February 2020
Contact information	Bjake Viberg: bjarke.viberg@rsyd.dk Anne Hansen: anne.jess.hansen@rsyd.dk
Notes	

NCT04462172

Study name	A prospective multicenter RCT about internal fixation using FNS versus MCS for femoral neck fracture
Methods	RCT; parallel design **Review comparison group:** screw vs fixed angle plate
Participants	**Estimated number of participants:** 290 **Inclusion criteria:** ≥ 18 years of age; unilateral femoral neck fractures treated with internal fixation; fracture type 31-B; able to understand informed consent documents and patient questionnaires (with help of relatives); able to provide informed consent (with help of relatives); investigator believes participant able to understand study; in-label use of MCS and FNS **Exclusion criteria:** not providing informed consent; investigator believes that participants have conditions that disallow study follow-up; pregnant or lactating women; psychological disorders; Garden's classification III and IV in participants > 65 years; concurrent hip osteoarthritis; operative treatment occurring > 3 weeks after injury; pathological fracture; serious soft tissue injury; multiple systemic injuries; revision surgery; concurrent medical conditions; anaesthetic and surgical contraindications; known allergies to implant components; receiving chemotherapeutics, radiotherapy, systemically corticosteroid hormone or growth factor, long-term use of sedative hypnotics, or NSAIDs; intemperance (e.g. excessive alcohol consumption or smoking, or drug abuse); participating in other clinical studies; significant neurological or musculoskeletal disorders having adverse effect on gait or weight bearing **Setting:** Peking University Third Hospital, China
Interventions	Femoral neck system (DHS and MCS) vs 3 cancellous screws

NCT04462172 *(Continued)*

Outcomes	Internal fixation rate; non-union; HHS, operation time; time to intraoperative fluoroscopy; postoperative adverse events; Garden index; HRQoL
Starting date	Estimated start date: 1 July 2020
Contact information	Study leader: Fang Zhou, Email: 307542744@qq.com Location: Peking University Third Hospital, China
Notes	

UMIN000011303

Study name	A randomised controlled trial comparing bipolar hemiarthroplasty with total hip replacement for displaced intracapsular fractures of the femoral neck in active patients
Methods	RCT, parallel group Comparison: THA versus HA (bipolar)
Participants	**Estimated number of participants**: 240 **Inclusion criteria**: 20 to 76 years of age, with displaced intracapsular fracture of femoral neck suitable for treatment with either THA or bipolar HA, femoral head size > 36 mm, walking independently without any orthosis, able to give informed consent and adhere to follow-up **Exclusion criteria**: history of infectious disease, previous hip surgery, BMI > 40 kg/m^2, pregnancy, history of neurological disease, history of Paget's disease, history of steroid therapy or immunosuppression therapy **Settings**: Japan
Interventions	THA Bipolar HA
Outcomes	Functional outcome (JOA score, walking ability); patient satisfaction (EQ-5D, JHEQ); radiographic evaluation
Starting date	1 Ocotber 2013
Contact information	Yukiharu Hasegawa; taekgami-toyomh@umin.ac.jp
Notes	

Wolf 2020a

Study name	The DUALITY trial - a register-based, randomised controlled trial to investigate dual-mobility cups in hip fracture patients
Methods	Multicentre, register-nested, randomised controlled trial
Participants	**Estimated number of participants**: 1600

Wolf 2020a *(Continued)*

	Inclusion criteria: > 65 years of age, with a displaced femoral neck fracture who are eligible for a THA ; Garden's III-IV fracture **Exclusion criteria**: cognitive impairment, previous inclusion of a contralateral THA in the ongoing trial, delayed fracture surgery (date of injury more than seven days prior to date of screening), pathological or stress fracture of the femoral neck, and fracture adjacent to a previous ipsilateral hip implant, such as a previously inserted screw or plate **Settings**: Sweden
Interventions	Dual-mobility cup (Avantage (Zimmer Biomet, Warsaw, IN, USA), Polar (Smith & Nephew, London, UK), or Ades (Zimmer Biomet); surgeon preference Standard cup (Lubinus (Waldemar Link, Hamburg, Germany), Marathon (DePuy Synthes, Warsaw, IN, USA), Exeter RimFit (Stryker, Kalamazoom MI, USA), or Lubinus IP (Waldemar Link) cups); surgeon preference
Outcomes	Dislocation; re-operation; mortality; HRQoL (EQ-5D)
Starting date	January 2020
Contact information	Olof Wolf: olof.wolf@surgsci.uu.se
Notes	

Wolf 2020b

Study name	Hips screws or (total) hip replacement for undisplaced femoral neck fractures in elderly patients (HipSTHeR)
Methods	RCT, parallel design Multi-centre study; Sweden
Participants	**Estimated number of participants:** 1440 **Inclusion criteria:** undisplaced (Garden's I to II) femoral neck fracture (within 72 hours); treated at participating unit; informed consent; amenable for both treatment options **Exclusion criteria:** no informed consent; pathological or stress fracture; peri-implant fracture
Interventions	Hemi- or total arthroplasty (depending on hospital) vs internal fixation with 2 to 3 screws or pins or a sliding hip screw
Outcomes	Mortality (30 days; 1 year; 2 years); re-operation rate; SMFA; EQ-5D; adverse events; external validity; health economics
Starting date	16 September 2019
Contact information	Olof Wolf: olof.worl@surgsci.uu.se
Notes	

ASA: American Society of Anesthesiologists; **AVN:** avascular necrosis; **BMI:** body mass index; **CDC:** Centre for Disease Control; **COPD:** chronic obstructive pulmonary disease; **CT:** computed tomography; **DEXA:** dual energy x-ray absorptiometry; **DHS:** dynamic hip screw; **DLBP:** dynamic locking blade plate; **EQ-5D (5L):** EuroQoL 5 Dimensions (5 levels) instrument; **FNS:** femoral neck system; **HA:** hemiarthroplasty; **HHS:** Harris hip score; **HRQoL:** health-related quality of life; **ISS:** Injury Severity Score; **JHEQ:** Japanese

Orthopaedic Association hip disease evaluation questionnaire; **JOA:** Japanese Orthopaedic Association; **MCS:** multiple cancellous screws; **NSAID:** non-steroidal anti-inflammatory drug; **OHS:** Oxford hip score; **RA:** rheumatoid arthritis; **RCT:** randomised controlled trial; **RSA:** radiostereometric analysis; **SF-36:** Short form-36; **SHS:** sliding hip screw; **SLE:** systemic lupus erythematosis; **SMFA:** short musculoskeletal functional assessment; **SPMSQ:** short portable mental status questionnaire; **THA:** total hip arthroplasty; **TUG:** Timed Up and Go; **UCLA:** University of California, Los Angeles; **THA:** total hip arthroplasty; **VAS:** visual analogue score; **WOMAC:** Western Ontario and McMaster Universities Osteoarthritis Index

ADDITIONAL TABLES

Table 1. Categorisation of interventions for intracapsular hip fractures

Implant	Grouping variable	Implant sub-category	Examples[a]	Description	In worldwide use (yes/no)
Intracapsular fractures					
Internal fixation					
Smooth pins	n/a	Single or multiple pins	• Hansson pins • Hessel pins	Smooth pin: any pin, hook pin or nail treatment, regardless of the number implanted. Smooth pins are unthreaded and may offer greater stiffness than their threaded counterparts. Hansson pin (Elos Medtech, 1982): a hook pin designed like a Rydell nail, with the same spring pin but with removed flanges. Earlier the pin was hammered in place, but in 1985 the instrument became more sophisticated and it was instead gently inserted with the use of a three-part system. The pin implant was offered in lengths from 70 to 140 mm, in increasing steps of 5 mm, with a diameter of 6.5 mm. It was manufactured in stainless steel for the European market and in titanium for the Japanese market. Since 2006, Anodizing Type II, which is an oxide formula, has been used in Japan to prevent osseointegration of the pin. The surfaces had to be extremely smooth and fine, partly so that the pin implant should not grow solid into the bone, and partly because it had to be easy to assemble the pin implant. Hessel pin: a thin, smooth pin without threads, which is inserted by hammering.	
	n/a	Single or multiple nails	• Smith-Petersen nail • Rydell four-flanged nail • Nystrom nail	Smith-Petersen nail: a three-flanged steel nail introduced in 1925 for insertion across the fracture site in hip fractures. Rydell four-flanged nail: a spring-loaded nail which had four flanges and was hammered in over a guide pin. The pin had a curved	

Table 1. Categorisation of interventions for intracapsular hip fractures *(Continued)*

			• Thornton nail	end which extruded through a hole in the nail and anchored the pin in the bone in order to prevent slippage. Nystrom nail: a sharp-tipped smooth nail which was hammered across the fracture and thought to have better penetrating ability. Thornton nail: a four-flanged, smooth nail which is hammered across the fracture.
Screw treatment	n/a	Single or multiple screws	• Garden screws • Richards screws • Tronzon (VLF) screws • Uppsala/Olmed screws • Von Bahr screws • AO screws • Gouffon screws • Mecron screws • Ulleval screws • Scand screws • Mecron screws	Any screw providing fixation; the number of screws, size of screws, thread length, diameter and configuration may all vary. Hip screws are typically cancellous screws that have coarser threads and may have an unthreaded portion allowing it to act as a lag screw. However, both fully and partially threaded variants are available.
Fixed angle plates	n/a	Static	• Holt nail plate • Jewett nail plate • McLaughlin nail plate • Thornton nail plate	Static device consisting of a nail, pin or screw which is passed across the fracture into the femoral head and connected to a plate on the lateral femur. These implants have no capacity for 'sliding' between the plate and pin or screw components and hence are termed 'static implants'. Holt nail plate: a four-flanged nail connected to a plate at the time of surgery Jewett nail: the nail is fixed to the plate at manufacture

Table 1. Categorisation of interventions for intracapsular hip fractures *(Continued)*

		Thornton and McLaughlin nail plates: the nail is connected to the plate at the time of surgery with a locking bolt
Dynamic	• Dynamic hip screw • Precimed Hip Screw System • AMBI/Classic Hip Screw System (Smith & Nephew Richards) • DHS/DCS Dynamic Hip & Condylar Screw System • Synthec-Taichung DHS/DCS Plate System • Targon Femoral Neck hip Screw • Richards sliding screw plate	Dynamic device consisting of a nail, pin or screw which is passed across the fracture into the femoral head and connected to a plate on the lateral femur. These implants allow 'sliding' between the plate and pin or screw components and hence are termed dynamic implants. Weight bearing or translation during surgery causes the femoral head to become impacted on the femoral neck producing compression of the fracture. Precimed Hip Screw System: compression fixation system used for the treatment of femoral neck and distal femoral fractures. It consists of compression plates, lag screws, compression screws, bone screws and angled blade plates. The system functions to provide immediate stability and temporary fixation during the natural healing process following fractures of the femoral neck or distal femur. AMBI/Classic Hip Screw System: compression fixation system consisting of hip screw plates and nails. AMBI plates have a barrel design which is keyless but can be converted to keyed with the insertion of a small keying clip; Classic plates have a keyed barrel design only. AMBI/Classic Lag Screws: 18 lengths: 55 mm to 140 mm; nonself-tapping for cancellous bone Targon Femoral Neck screws (B. Braun Group): distal and proximal screws are linked with a locking plate
Neither static or dynamic	• Dynaloc • Hansson Pinloc System	Dynaloc - a construct made up of 3 parallel cannulated screws which are each independently passed through and screwed into a plate positioned on the lateral surface of the femur. Hansson Pinloc System - a development of the Hansson pin. A construct made up of 3 parallel Hansson pins which are each independently passed through and screwed into a plate positioned on the lateral surface of the femur.

Table 1. Categorisation of interventions for intracapsular hip fractures *(Continued)*

Arthroplasty				

Total hip arthroplasty	Articulation	Femoral head and acetabular bearing surface materials	• Metal-on-polyethylene
			• Ceramic-on-polyethylene
			• Ceramic-on-ceramic
			• Metal-on-metal
			• Polyethylene material
			  ○ HCL
			  ○ not HCL
				Bearing surfaces may be grouped into hard (ceramic and metal) and soft (polyethylene variants). Arthroplasties exist with many of the possible combinations of these bearing surfaces.

		Femoral head size	• Large head ≥ 36 mm • Standard small head < 36 mm	Over the development of hip arthroplasty, different sizes of femoral head have been used, from 22 mm to very large diameters approximating that of the native femoral head. The size of the head represents a compromise between stability and linear and volumetric wear at the articulation. The optimum size varies by indication and bearing materials. 36 mm is considered as a cut-off between standard and large sizes.
		Acetabular cup mobility	• Single • Dual	A standard total hip arthroplasty has a single articulating surface between the femoral head and acetabulum bearing surface. Alternative designs incorporate a further articulation within the structure of the femoral head.
	Fixation technique	Cemented	• Exeter Hip System • CPT Hip System	Both components are cemented with poly(methyl methacrylate) bone cement that is inserted at the time of surgery. It sets hard and acts as grout between the prosthesis and the bone.
		Modern uncemented	• Corail Hip System • Avenir Hip System • Taperloc Hip System	Neither component is cemented but rely on osseous integration forming a direct mechanical linkage between the bone and the implant. The femoral prosthesis may be coated with a substance such as hydroxyapatite which promotes bone growth into the prosthesis. Alternatively, the surface of the prosthesis may be macroscopically and microscopically roughened so that bone grows onto the surface of the implant. The acetabular component may be prepared similar-

Table 1. Categorisation of interventions for intracapsular hip fractures *(Continued)*

				ly and may or may not be augmented with screws fixed into the pelvis.
		Hybrid	Combinations	The femoral stem is cemented and the acetabular cup is uncemented.
		Reverse hybrid	Combinations	The acetabular cup is cemented and the femoral stem is uncemented
Hemiarthroplasty	Articulation	Unipolar	• Thompson • Austin-Moore • Exeter Trauma Stem • Exeter Unitrax • Endo Femoral Head • CPT Zimmer • Unitrax	A single articulation between the femoral head and the native acetabulum. The femoral component can be a single 'monoblock' of alloy or be modular, assembled from component parts during surgery.
		Bipolar	• CPT modular biploar • Exeter modular biploar • Bateman • Monk • Centrax	The object of the second joint is to reduce acetabular wear. This type of prosthesis has a spherical inner metal head with a size between 22 and 36 mm in diameter. This fits into a polyethylene shell, which in turn is enclosed by a metal cap. There are a number of different types of prostheses with different stem designs.
	Fixation technique	First-generation uncemented	• Thompson • Austin Moore	These prostheses were designed before the development of poly(methyl methacrylate) bone cement and were therefore originally inserted as a 'press fit'. Long-term stability through osseus integration was not part of the design concept.
		Cemented	• Thompson • Exeter Trauma Stem • Exeter Hip System • CPT Hip System	The femoral stem is cemented with poly(methyl methacrylate) bone cement that is inserted at the time of surgery. It sets hard and acts as grout between the prosthesis and the bone.
		Modern uncemented	• Corail • Furlong • Avenir	The femoral stem relies on osseous integration forming a direct mechanical linkage between the bone and the implant. A prosthe-

Table 1. Categorisation of interventions for intracapsular hip fractures *(Continued)*

	sis may be coated with a substance such as hydroxyapatite which promotes bone growth into the prosthesis. Alternatively, the surface of the prosthesis may be macroscopically and microscopically roughened so that bone grows onto the surface of the implant.

[a] This list is not exhaustive.
Abbreviations: **CoC:** ceramic-on-ceramic; **CoP:** ceramic-on-polyethylene; **CPT:** collarless polished tapered; **DCS:** dynamic condylar screw; **DHS:** dynamic hip screw; **HCL:** highly cross-linked; **MoM:** metal-on-metal; **MoP:** metal-on-polyethylene; **THA:** total hip arthroplasty

Table 2. Early mortality: network estimates, direct estimates and indirect estimates

Cemented modern unipolar HA	D: 2.60 (0.29 to 23.50) I: 0.86 (0.46 to 1.58)			D: 0.93 (0.57 to 1.49) I: 1.25 (0.67 to 2.36)	D: 0.98 (0.67 to 1.42) I: 0.77 (0.22 to 2.76)	D: 0.99 (0.69 to 1.42) I: 0.95 (0.02 to 46.99)	D: 2.04 (0.19 to 21.80) I: 0.70 (0.29 to 1.72)			D: 0.98 (0.60 to 1.59) I: 1.00 (0.57 to 1.75)	
0.93 (0.51 to 1.68)	**Dynamic fixed angle plate**			D: 4.78 (0.24 to 94.12) I: 1.05 (0.56 to 1.94)				D: 1.32 (0.67 to 2.62) I: 0.69 (0.33 to 1.46)		D: 0.84 (0.44 to 1.59) I: 1.46 (0.70 to 3.07)	
1.34 (0.43 to 4.18)	1.44 (0.42 to 4.92)	**Uncemented first-generation bipolar HA**	D: 0.35 (0.07 to 1.82) I: 1.27 (0.29 to 5.64)	D: 1.28 (0.32 to 5.19) I: 0.36 (0.06 to 2.00)							
0.95 (0.52 to 1.72)	1.03 (0.49 to 2.14)	0.71 (0.24 to 2.15)	**Uncemented modern bipolar HA**	D: 1.05 (0.57 to 1.94) I: 1.17 (0.47 to 2.88)		D: 1.00 (0.02 to 47.19) I: 1.04 (0.51 to 2.09)		D: 1.00 (0.07 to 15.26) I: too imprecise		D: 0.89 (0.35 to 2.28) I: 1.13 (0.56 to 2.29)	D: 0.64 (0.22 to 1.82) I: 1.02 (0.11 to 9.55)
1.03 (0.71 to 1.51)	1.11 (0.61 to 2.04)	0.77 (0.26 to 2.29)	1.09 (0.65 to 1.80)	**Cemented modern bipolar HA**			D: 0.69 (0.20 to 2.33) I: 0.86 (0.29 to 2.56)			D: 0.93 (0.53 to 1.64) I: 0.97 (0.57 to 1.64)	
0.96 (0.67 to 1.37)	1.03 (0.53 to 2.04)	0.72 (0.22 to 2.36)	1.01 (0.51 to 2.00)	0.93 (0.56 to 1.55)	**Uncemented first-generation unipolar HA**					D: 1.25 (0.37 to 4.21) I: 0.99 (0.58 to 1.69)	

Table 2. Early mortality: network estimates, direct estimates and indirect estimates *(Continued)*

0.99 (0.69 to 1.41)	1.06 (0.53 to 2.13)	0.74 (0.22 to 2.44)	1.04 (0.52 to 2.07)	0.96 (0.57 to 1.61)	1.03 (0.62 to 1.71)	**Uncemented modern unipolar HA**					
0.80 (0.35 to 1.85)	0.86 (0.34 to 2.21)	0.60 (0.16 to 2.31)	0.84 (0.33 to 2.15)	0.78 (0.34 to 1.75)	0.84 (0.34 to 2.06)	0.81 (0.33 to 2.02)	**THA (single articulation)**			D: 1.38 (0.44 to 4.34) I: 1.10 (0.35 to 3.44)	
0.95 (0.06 to 15.48)	1.03 (0.06 to 17.26)	0.71 (0.04 to 13.47)	1.00 (0.07 to 15.26)	0.92 (0.06 to 14.73)	0.99 (0.06 to 16.47)	0.96 (0.06 to 16.04)	1.19 (0.07 to 21.17)	**Dual-mobility THA**			
0.91 (0.53 to 1.56)	0.98 (0.59 to 1.63)	0.68 (0.21 to 2.27)	0.96 (0.48 to 1.91)	0.88 (0.51 to 1.53)	0.95 (0.51 to 1.78)	0.92 (0.49 to 1.76)	1.14 (0.46 to 2.80)	0.96 (0.06 to 15.73)	**Pin treatment**	D: 1.22 (0.79 to 1.89) I: 0.64 (0.26 to 1.59)	
0.99 (0.68 to 1.42)	1.06 (0.66 to 1.72)	0.74 (0.24 to 2.29)	1.04 (0.59 to 1.82)	0.95 (0.65 to 1.40)	1.03 (0.63 to 1.68)	1.00 (0.60 to 1.67)	1.23 (0.55 to 2.76)	1.04 (0.06 to 16.54)	1.08 (0.73 to 1.60)	**Screw treatment**	D: 0.71 (0.24 to 2.10) I: 0.45 (0.05 to 3.99)
0.65 (0.23 to 1.84)	0.70 (0.23 to 2.12)	0.49 (0.12 to 2.06)	0.68 (0.25 to 1.84)	0.63 (0.23 to 1.74)	0.68 (0.23 to 2.02)	0.66 (0.22 to 1.98)	0.81 (0.23 to 2.88)	0.68 (0.04 to 12.25)	0.71 (0.24 to 2.09)	0.66 (0.24 to 1.80)	**Non-operative treatment**

Intervention effects expressed as risk ratios (with 95% confidence intervals) of early mortality (≤ 4 months). In the lower triangle (network estimates), the column-defining intervention is the reference group; a risk ratio lower than 1 favours the row-defining intervention for the network meta-analysis results. In the upper triangle (direct estimates (D) and indirect estimates (I)), the row-defining intervention is the reference group; a risk ratio lower than 1 favours the column-defining intervention for the pair-wise meta-analysis. Blank spaces indicate that no direct estimate was available and the network estimate was derived from indirect evidence only. **HA:** hemiarthroplasty; **THA:** total hip arthroplasty

Table 3. Early mortality: estimated probabilities of rankings

Rank	Non-operative treatment	THA (single articulation)	Pin treatment	Dynamic fixed angle plate	Uncemented modern	Dual-mobility THA	Uncemented first-generation unipolar HA	Uncemented modern	Screw treatment	Cemented modern	Cemented modern	Uncemented first-generation bipolar HA

Table 3. Early mortality: estimated probabilities of rankings *(Continued)*

					bipolar HA			unipolar HA		unipolar HA	bipolar HA	
Best	33.0	15.8	2.9	4.2	1.8	33.0	2.1	2.2	0.2	0.3	0.2	4.3
2nd	23.0	19.7	9.3	9.6	8.0	7.5	6.5	5.9	1.1	1.3	1.3	6.7
3rd	10.3	13.2	13.2	12.3	12.2	3.7	10.5	7.8	4.0	4.0	3.5	5.4
4th	5.9	8.3	13.8	11.5	11.6	2.6	10.6	10.0	8.0	7.7	5.9	4.0
5th	4.4	6.4	11.5	9.8	9.8	1.9	10.4	9.4	13.0	10.8	8.6	3.9
6th	3.2	5.0	9.6	8.4	8.9	1.5	10.3	10.2	15.0	13.4	11.3	3.2
7th	2.8	4.9	8.4	7.7	8.5	1.4	9.4	9.5	16.1	15.1	13.0	3.1
8th	2.6	4.2	8.2	7.6	7.8	1.6	9.9	10.2	14.8	15.8	13.8	3.4
9th	3.0	4.6	7.4	7.7	9.3	1.9	9.6	10.0	12.8	13.9	15.7	4.0
10th	3.9	5.9	7.5	8.4	10.8	2.6	8.8	10.8	9.2	10.7	14.8	6.6
11th	4.8	7.2	5.7	8.3	8.5	7.7	8.3	9.2	4.7	5.5	9.1	20.7
Worst	3.1	4.7	2.3	4.3	2.6	34.7	3.7	4.7	1.1	1.4	2.8	34.5
Mean rank	**3.7**	**4.9**	**5.9**	**6.2**	**6.4**	**6.5**	**6.6**	**6.9**	**7.0**	**7.2**	**7.7**	**8.8**
SUCRA	**0.8**	**0.6**	**0.6**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.4**	**0.4**	**0.3**

Estimated probabilities of rankings, mean rank and SUCRA for each treatment in the 'mortality at 4 months' network based on random-effects consistency network meta-analysis (sorted by mean rank from left to right). **HA:** hemiarthroplasty; **SUCRA:** surface under the cumulative ranking area; **THA:** total hip arthroplasty

Table 4. Mortality at 12 months: network estimates, direct estimates and indirect estimates

Cemented modern unipolar HA	D: 1.00 (0.55 to 1.82) I: 1.02 (0.77 to 1.37)	D: 1.17 (0.89 to 1.54) I: 1.09 (0.75 to 1.57)	D: 1.07 (0.83 to 1.37)	D: 1.17 (0.93 to 1.46)	D: 1.33 (0.47 to 3.75)	D: 1.04 (0.77 to 1.41) I: 1.13 (0.88 to 1.45)

Table 4. Mortality at 12 months: network estimates, direct estimates and indirect estimates *(Continued)*

					I: 1.04 (0.73 to 1.48)	I: 0.68 (0.07 to 6.80)	I: 1.66 (1.14 to 2.44)			
1.02 (0.79 to 1.32)	**Dynamic fixed angle plate**			D: 1.59 (0.76 to 3.32) I: 1.05 (0.77 to 1.44)					D: 1.01 (0.65 to 1.59) I: 1.01 (0.74 to 1.39)	D: 1.04 (0.83 to 1.31) I: 1.15 (0.79 to 1.67)
1.42 (0.82 to 2.45)	1.39 (0.78 to 2.47)	**Unce-mented first-gener-ation bipolar HA**	D: 0.81 (0.46 to 1.43) I: 1.59 (0.62 to 4.07)	D: 1.28 (0.52 to 3.19) I: 0.65 (0.35 to 1.20)						
1.37 (1.02 to 1.85)	1.35 (0.95 to 1.90)	0.97 (0.60 to 1.58)	**Unce-mented modern bipolar HA**	D: 0.78 (0.61 to <1.00) I: 1.13 (0.65 to 1.95)	D: 3.00 (0.13 to 69.52) I: 0.76 (0.54 to 1.06)	D: 0.50 (0.05 to 4.90) I: 0.86 (0.59 to 1.24)		D: 0.80 (0.24 to 2.69) I: 0.73 (0.09 to 5.85)	D: 0.95 (0.49 to 1.81) I: 0.76 (0.54 to 1.06)	D: 0.87 (0.45 to 1.70) I: 0.56 (0.15 to 2.14)
1.14 (0.92 to 1.42)	1.12 (0.84 to 1.49)	0.81 (0.49 to 1.34)	0.83 (0.67 to 1.04)	**Cemented modern bipolar HA**			D: 1.72 (1.06 to 2.78) I: 1.16 (0.71 to 1.90)		D: 0.89 (0.57 to 1.38) I: 0.99 (0.75 to 1.29)	
1.06 (0.86 to 1.30)	1.04 (0.78 to 1.37)	0.75 (0.42 to 1.32)	0.77 (0.55 to 1.08)	0.93 (0.71 to 1.22)	**Unce-mented first-gen-eration unipolar HA**				D: 1.06 (0.81 to 1.39) I: 1.00 (0.71 to 1.40)	
1.16 (0.93 to 1.45)	1.14 (0.81 to 1.60)	0.82 (0.45 to 1.48)	0.84 (0.58 to 1.22)	1.02 (0.75 to 1.38)	1.10 (0.81 to 1.48)	**Unce-mented modern**				

Table 4. Mortality at 12 months: network estimates, direct estimates and indirect estimates *(Continued)*

						unipolar HA					
1.62 (1.13 to 2.32)	1.59 (1.08 to 2.34)	1.14 (0.62 to 2.10)	1.18 (0.79 to 1.76)	1.42 (1.01 to 2.00)	1.53 (1.04 to 2.25)	1.40 (0.92 to 2.13)	**THA (single articulation)**	D: 0.62 (0.08 to 4.78) I: 0.68 (0.19 to 2.44)	D: 0.64 (0.12 to 3.48) I: 0.64 (0.42 to 0.96)	D: 0.80 (0.48 to 1.34) I: 0.59 (0.37 to 0.93)	
1.07 (0.37 to 3.14)	1.05 (0.35 to 3.12)	0.76 (0.24 to 2.40)	0.78 (0.27 to 2.23)	0.94 (0.33 to 2.71)	1.01 (0.34 to 3.00)	0.92 (0.31 to 2.77)	0.66 (0.22 to 1.96)	**Dual-mobility THA**			
1.03 (0.78 to 1.37)	1.01 (0.78 to 1.31)	0.73 (0.41 to 1.13)	0.75 (0.52 to 1.08)	0.90 (0.66 to 1.23)	0.98 (0.73 to 1.31)	0.89 (0.62 to 1.27)	0.64 (0.43 to 0.95)	0.96 (0.32 to 2.87)	**Pin treatment**	D: 1.06 (0.84 to 1.34) I: 1.06 (0.65 to 1.71)	
1.09 (0.90 to 1.33)	1.07 (0.88 to 1.30)	0.77 (0.45 to 1.34)	0.80 (0.59 to 1.07)	0.96 (0.76 to 1.21)	1.03 (0.84 to 1.28)	0.94 (0.70 to 1.26)	0.68 (0.48 to 0.95)	1.02 (0.35 to 2.98)	1.06 (0.86 to 1.31)	**Screw treatment**	D: 0.92 (0.47 to 1.83) I: 1.43 (0.39 to 5.31)
1.10 (0.59 to 2.07)	1.08 (0.57 to 2.05)	0.78 (0.36 to 1.69)	0.80 (0.44 to 1.48)	0.97 (0.52 to 1.79)	1.04 (0.55 to 1.98)	0.95 (0.49 to 1.85)	0.68 (0.34 to 1.35)	1.03 (0.31 to 3.43)	1.07 (0.56 to 2.04)	1.01 (0.55 to 1.86)	**Non-operative treatment**

Intervention effects expressed as risk ratios (with 95% confidence intervals) of mortality at 12 months. In the lower triangle (network estimates), the column-defining intervention is the reference group; a risk ratio lower than 1 favours the row-defining intervention for the network meta-analysis results. In the upper triangle (direct estimates (D) and indirect estimates (I)), the row-defining intervention is the reference group; a risk ratio lower than 1 favours the column-defining intervention for the pair-wise meta-analysis. Blank spaces indicate that no direct estimate was available and the network estimate was derived from indirect evidence only. **HA:** hemiarthroplasty; **THA:** total hip arthroplasty

Table 5. Mortality at 12 months: estimated probabilities of rankings

Rank	Cemented modern	Dynamic fixed angle plate	Pin treatment	Uncemented first-generation unipolar HA	Dual-mobility THA	Screw treatment	Non-operative treatment	Cemented modern	Uncemented modern	Uncemented first-generation	Uncemented modern	THA (single articulation)

Table 5. Mortality at 12 months: estimated probabilities of rankings *(Continued)*

	unipolar HA							**bipolar HA**	**unipolar HA**	**bipolar HA**	**bipolar HA**	
Best	11.3	11.5	10.4	5.0	35.1	0.4	20.3	0.9	2.0	3.0	0.0	0.0
2nd	21.6	17.6	16.8	11.1	6.7	2.1	12.1	3.2	4.3	4.1	0.3	0.0
3rd	22.5	16.8	15.2	13.6	3.6	7.2	5.9	5.6	5.9	3.0	0.5	0.1
4th	17.3	14.2	13.0	14.9	2.8	13.3	5.0	8.2	7.5	2.8	0.7	0.2
5th	12.3	12.0	11.7	14.2	2.5	20.0	4.5	10.1	8.9	2.3	1.2	0.2
6th	8.6	9.6	9.8	13.5	2.4	20.7	4.6	14.1	11.1	3.0	1.9	0.7
7th	3.9	7.8	8.6	11.2	3.3	16.6	5.8	20.0	13.8	4.0	3.9	1.0
8th	1.7	5.2	6.4	7.9	4.5	11.5	8.1	20.4	15.7	6.7	9.1	2.9
9th	0.5	3.1	4.2	4.7	6.0	5.5	9.4	13.2	14.2	10.4	21.7	7.2
10th	0.1	1.6	2.6	2.8	6.2	2.1	8.6	3.7	9.6	15.1	33.0	14.4
11th	0.0	0.6	1.1	1.0	8.8	0.5	8.7	0.6	5.6	21.8	21.9	29.4
Worst	0.0	0.0	0.1	0.1	18.3	0.0	7.1	0.0	1.2	23.6	5.7	43.8
MEAN RANK	**3.5**	**4.2**	**4.5**	**5.0**	**5.9**	**5.9**	**5.9**	**6.6**	**6.9**	**9.1**	**9.6**	**10.9**
SUCRA	**0.8**	**0.7**	**0.7**	**0.6**	**0.6**	**0.6**	**0.6**	**0.5**	**0.5**	**0.3**	**0.2**	**0.1**

Estimated probabilities of rankings, mean rank and SUCRA for each treatment in the 'mortality at 12 months' network based on random-effects consistency network meta-analysis (sorted by mean rank from left to right). **HA:** hemiarthroplasty; **SUCRA:** surface under the cumulative ranking area; **THA:** total hip arthroplasty

Table 6. Late mortality: network estimates, direct estimates and indirect estimates

Cemented modern unipolar HA	D: 0.71 (0.41 to 1.21) I: 0.89 (0.56 to 1.40)	D: 0.93 (0.71 to 1.24) I: 0.67 (0.48 to 0.93)	D: 0.95 (0.77 to 1.18) I: 1.05 (0.75 to 1.47)	D: 0.63 (0.37 to 1.10) I: 0.97 (0.76 to 1.24)

Table 6. Late mortality: network estimates, direct estimates and indirect estimates *(Continued)*

0.81 (0.57 to 1.15)	**Dynamic fixed angle plate**		D: 1.12 (0.68 to 1.84) I: 0.85 (0.52 to 1.39)	D: 1.57 (0.83 to 2.97) I: 1.08 (0.71 to 1.64)		D: 0.39 (0.17 to 0.91) I: 1.31 (0.90 to 1.91	
0.85 (0.65 to 1.10)	1.05 (0.71 to 1.56)	**Uncemented modern bipolar HA**	D: 0.93 (0.72 to 1.21) I: 0.91 (0.60 to 1.37)		D: 0.71 (0.25 to 2.06) I: 1.09 (0.85 to 1.41)	D: 1.06 (0.70 to 1.60) I: 1.00 (0.74 to 1.35)	D: 0.98 (0.64 to 1.50) I: 0.87 (0.34 to 2.20)
0.79 (0.65 to 0.95)	0.97 (0.69 to 1.38)	0.93 (0.76 to 1.14)	**Cemented modern bipolar HA**		D: 1.36 (1.09 to 1.70) I: 1.00 (0.82 to 1.23)	D: 1.10 (0.88 to 1.38) I: 1.09 (0.85 to 1.40)	
0.98 (0.84 to 1.14)	1.21 (0.86 to 1.71)	1.15 (0.90 to 1.48)	1.24 (1.04 to 1.48)	**Uncemented first-generation unipolar HA**		D: 0.88 (0.70 to 1.11) I: 0.86 (0.57 to 1.31)	
0.91 (0.74 to 1.11)	1.12 (0.78 to 1.62)	1.07 (0.84 to 1.36)	1.15 (0.99 to 1.35)	0.93 (0.77 to 1.12)	**THA (single articulation)**	D: 1.00 (0.86 to 1.17) I: 0.86 (0.68 to 1.09)	
0.86 (0.72 to 1.03)	1.07 (0.76 to 1.52)	1.02 (0.82 to 1.27)	1.10 (0.96 to 1.26)	0.89 (0.77 to 1.02)	0.95 (0.83 to 1.10)	**Screw treatment**	D: 0.92 (0.61 to 1.40) I: 1.04 (0.41 to 2.68)
0.81 (0.54 to 1.22)	1.01 (0.61 to 1.66)	0.96 (0.66 to 1.40)	1.03 (0.71 to 1.51)	0.83 (0.56 to 1.24)	0.90 (0.61 to 1.33)	0.94 (0.65 to 1.36)	**Non-operative treatment**

Intervention effects expressed as risk ratios (with 95% confidence intervals) of late mortality (> 24 months). In the lower triangle (network estimates), the column-defining intervention is the reference group; a risk ratio lower than 1 favours the row-defining intervention for the network meta-analysis results. In the upper triangle (direct estimates (D) and indirect estimates (I)), the row-defining intervention is the reference group; a risk ratio lower than 1 favours the column-defining intervention for the pair-wise meta-analysis. Blank spaces indicate that no direct estimate was available and the network estimate was derived from indirect evidence only. **HA:** hemiarthroplasty; **THA:** total hip arthroplasty

Table 7. Late mortality: estimated probabilities of rankings

Rank	Cemented modern bipolar HA	Dynamic fixed angle plate	Non-operative treatment	Uncemented modern bipolar HA	Screw treatment	THA (single articulation)	Uncemented first-generation unipolar HA

Table 7. Late mortality: estimated probabilities of rankings *(Continued)*

Best	25.1	31.9	32.2	8.8	1.1	0.7	0.1
2nd	39.7	16.4	15.3	17.2	7.5	3.2	0.3
3rd	24.9	11.1	10.9	20.5	20.6	9.4	1.3
4th	8.4	9.7	9.4	17.6	32.2	16.3	3.7
5th	1.5	8.6	7.9	14.4	26.6	24.9	9.4
6th	0.3	8.8	8.0	11.0	10.1	26.0	21.7
7th	0.1	6.0	5.7	5.9	1.8	11.8	39.6
Worst	0.0	7.4	10.5	4.6	0.2	7.6	23.8
MEAN RANK	**2.2**	**3.3**	**3.4**	**3.9**	**4.1**	**5.3**	**6.6**
SUCRA	**0.8**	**0.7**	**0.7**	**0.6**	**0.6**	**0.4**	**0.2**

Estimated probabilities of rankings, mean rank and SUCRA for each treatment in the 'mortality at 24 months' network based on random-effects consistency network meta-analysis (sorted by mean rank from left to right). **HA:** hemiarthroplasty; **SUCRA:** surface under the cumulative ranking area; **THA:** total hip arthroplasty

Table 8. Early HRQoL: network estimates, direct estimates and indirect estimates

Cemented modern unipolar HA		D: 0.27 to -0.10 to 0.64) I: -0.18 (-0.58 to 0.21)	D: -0.08 (-0.47 to 0.31) I: 0.37 (-0.11 to 0.84)	D: -0.41 (-1.15 to 0.32) I: -0.29 (-0.88 to 0.29)	
-0.06 (-0.44 to 0.31)	**Uncemented modern bipolar HA**	D: 0.21 (-0.25 to 0.67) I: -0.10 (-0.77 to 0.57)		D: -0.42 (-0.96 to 0.11) I: -0.11 (-0.72 to 0.50)	D: -0.42 (-0.95 to 0.10) I: 0.20 (-1.32 to 1.73)
0.06 (-0.21 to 0.33)	0.12 (-0.16 to 0.40)	**Cemented modern bipolar HA**	D: 0.17 (-0.15 to 0.50) I: -0.28 (-0.80 to 0.25)	D: -0.27 (-0.71 to 0.17) I: -0.58 (-1.10 to -0.06)	

Table 8. Early HRQoL: network estimates, direct estimates and indirect estimates *(Continued)*

-0.47 (-0.87 to -0.08)	-0.41 (-0.96 to 0.13)	-0.53 (-1.01 to -0.05)	**Uncemented modern unipolar HA**				
0.11 (-0.18 to 0.39)	0.17 (-0.21 to 0.54)	0.05 (-0.21 to 0.31)	0.58 (0.09 to 1.07)	**THA (single articulation)**	D: 1.14 (0.10 to 2.17) I: -0.13 (-124.10 to 123.83)		
1.24 (0.21 to 2.28)	1.30 (0.24 to 2.36)	1.19 (0.16 to 2.21)	1.72 (0.61 to 2.82)	1.14 (0.15 to 2.13)	**Dual-mobility THA**		
-0.33 (-0.67 to 0.01)	-0.27 (-0.57 to 0.04)	-0.38 (-0.64 to -0.13)	0.15 (-0.37 to 0.67)	-0.43 (-0.78 to -0.08)	-1.57 (-2.62 to -0.53)	**Screw treatment**	D: 0.00 (-0.53 to 0.53) I: -0.63 (-2.15 to 0.90)
-0.40 (-0.89 to 0.08)	-0.34 (-0.74 to 0.05)	-0.46 (-0.89 to -0.04)	0.07 (-0.56 to 0.69)	-0.51 (-1.00 to -0.02)	-1.65 (-2.75 to -0.55)	-0.08 (-0.47 to 0.31)	**Non-operative treatment**

Intervention effects expressed as standardised mean differences (SMDs) with 95% confidence intervals of early HRQoL (≤ 4 months). In the lower triangle (network estimates), the column-defining intervention is the reference group; a SMD with a negative value (< 0) favours the column-defining intervention for the network meta-analysis results. In the upper triangle ((direct estimates (D) and indirect estimates (I)), the row-defining intervention is the reference group; a SMD with a negative value (< 0) favours the row-defining intervention for the pair-wise meta-analysis. Blank spaces indicate that no direct estimate was available and the network estimate was derived from indirect evidence only. **HA:** hemiarthroplasty; **THA:** total hip arthroplasty.

Table 9. Early HRQoL: estimated probabilities of rankings

Rank	Dual-mobility THA	THA (single articulation)	Cemented modern bipolar HA	Cemented modern unipolar HA	Uncemented modern bipolar HA	Screw treatment	Non-operative treatment	Uncemented modern unipolar HA
Best	98.2	0.5	0.6	0.3	0.3	0	0	0
2nd	0.6	52.7	22.7	13.5	9.7	0.1	0.6	0.2
3rd	0.4	23.3	40	22.6	12.3	0.1	0.9	0.5
4th	0.3	14.7	29.2	31.6	20.8	0.7	1.6	1.1

Table 9. Early HRQoL: estimated probabilities of rankings *(Continued)*

5th	0.4	7.3	6.9	26.2	44.7	5	4.6	5
6th	0.1	1.2	0.6	4.9	10.2	43	22.3	17.7
7th	0.1	0.2	0.1	1	1.8	39.9	34.8	22.2
Worst	0	0	0	0	0.2	11.3	35.1	53.3
MEAN RANK	**1**	**2.8**	**3.2**	**3.9**	**4.4**	**6.6**	**6.9**	**7.2**
SUCRA	**1**	**0.7**	**0.7**	**0.6**	**0.5**	**0.2**	**0.2**	**0.1**

Estimated probabilities of rankings, mean rank and SUCRA for each treatment in the early HRQoL network based on fixed-effect consistency network meta-analysis (sorted by mean rank from left to right). **Treatment nodes: A:** uncemented modern bipolar hemiarthroplasty; **B:** cemented modern bipolar hemiarthroplasty; **C:** uncemented modern unipolar hemiarthroplasty;**D:** total hip arthroplasty; **E:** dual-mobility total hip arthroplasty; **F:** screws; **G:** non-operative treatment; **H:** cemented modern unipolar hemiarthroplasty. **HA:** hemiarthroplasty; **SUCRA:** surface under the cumulative ranking area; **THA:** total hip arthroplasty

Table 10. HRQoL at 12 months: network estimates, direct estimates and indirect estimates

Cemented modern unipolar HA			D: 0.10 (-0.49 to 0.70) I: 0.15 (-0.41 to 0.71)	D: -0.07 (-0.49 to 0.35) I: -1.61 (-2.59 to -0.62)	D: 0.07 (-0.50 to 0.63) I: 0.23 (-0.36 to 0.82)	D: -0.61 (-1.38 to 0.16) I: -0.05 (-0.53 to 0.43)	
-0.45 (-0.95 to 0.06)	**Dynamic fixed angle plate**					D: 0.25 (-0.09 to 0.60) I: -0.41 (-71.98 to 71.17)	
0.09 (-0.39 to 0.57)	0.53 (-0.06 to 1.13)	**Uncemented modern bipolar HA**	D: 0.25 (-0.17 to 0.66) I: -0.28 (-0.83 to 0.26)	D: -1.43 (-2.33 to -0.53) I: 0.11 (-0.47 to 0.68)		D: -0.25 (-0.90 to 0.39) I: -0.39 (-1.12 to 0.34)	D: -0.22 (-0.86 to 0.42) I: -0.49 (-2.33 to 1.35)
0.11 (-0.23 to 0.46)	0.56 (0.08 to 1.05)	0.02 (-0.36 to 0.41)	**Cemented modern bipolar HA**		D: 0.18 (-0.27 to 0.63) I: -0.15 (-0.64 to 0.34)	D: -0.28 (-0.85 to 0.28) I: -0.35 (-0.87 to 0.17)	
-0.35 (-0.86 to 0.15)	0.09 (-0.54 to 0.72	-0.45 (-1.14 to 0.24)	-0.47 (-1.07 to 0.13)	**Uncemented modern unipolar HA**			

Table 10. HRQoL at 12 months: network estimates, direct estimates and indirect estimates *(Continued)*

0.15 (-0.20 to 0.50)	0.59 (0.11 to 1.07)	0.06 (-0.43 to 0.54)	0.03 (-0.29 to 0.35)	0.51 (-0.08 to 1.10)	**THA (single articulation)**	D: -0.21 (-0.79 to 0.37) I: -0.45 (-0.98 to 0.08)	
-0.20 (-0.58 to 0.19)	0.25 (-0.09 to 0.60)	-0.29 (-0.71 to 0.13)	-0.31 (-0.62 to 0.00)	0.17 (-0.44 to 0.77)	-0.34 (-0.69 to 0.01)	**Screw treatment**	D: 0.03 (-0.61 to 0.67) I: 0.30 (-1.53 to 2.14)
-0.15 (-0.75 to 0.45)	0.30 (-0.34 to 0.94)	-0.24 (-0.75 to 0.27)	-0.26 (-0.80 to 0.28)	0.21 (-0.56 to 0.99)	-0.30 (-0.88 to 0.29)	0.05 (-0.46 to 0.56)	**Non-operative treatment**

Intervention effects expressed as standardised mean differences (SMDs) (with 95% confidence intervals) of HRQoL at 12 months. In the lower triangle (network estimates), the column-defining intervention is the reference group; a SMD with a negative value (< 0) favours the column-defining intervention for the network meta-analysis results. In the upper triangle ((direct estimates (D) and indirect estimates (I)), the row-defining intervention is the reference group; a SMD with a negative value (< 0) favours the row-defining intervention for the pair-wise meta-analysis. Blank spaces indicate that no direct estimate was available and the network estimate was derived from indirect evidence only. **HA:** hemiarthroplasty; **THA:** total hip arthroplasty.

Table 11. Late HRQoL: network estimates, direct estimates and indirect estimates

Cemented modern unipolar HA				D: 0.51 (-0.49 to 1.50) I: 0.46 (-0.44 to 1.37)		
0.18 (-0.76 to 1.13)	**Uncemented modern bipolar HA**	D: -0.29 (-0.87 to 0.28) I: -0.46 (-1.36 to 0.44)	D: -1.16 (-3.42 to 1.11) I: -0.43 (-1.27 to 0.41)		D: -0.04 (-0.12 to 0.04) I: 0.12 (-0.12 to 0.37)	D: -0.04 (-0.12 to 0.04) I: 0.29 (-0.28 to 0.86)
-0.16 (-1.09 to 0.78)	-0.34 (-0.74 to 0.06)	**Cemented modern bipolar HA**			D: 0.42 (-0.40 to 1.24) I: 0.25 (-0.24 to 0.74)	
-0.97 (-2.35 to 0.40)	-1.16 (-2.15 to -1.17)	-0.82 (-1.89 to 0.26)	**Uncemented modern unipolar HA**			
0.51 (-0.20 to 1.21)	0.32 (-0.31 to 0.96)	0.66 (0.05 to 1.28)	1.48 (0.30 to 2.66)	**THA (single articulation)**	D: -0.29 (-0.87 to 0.28) I: -0.30 (-0.89 to 0.29)	
0.21 (-0.63 to 1.05)	0.03 (-0.41 to 0.46)	0.37 (-0.04 to 0.77)	1.19 (0.11 to 2.27)	-0.29 (-0.76 to 0.17)	**Screw treatment**	D: 0.00 (0.00 to 0.00) I: -0.33 (-0.98 to 0.32)
0.18 (-0.82 to 1.17)	-0.01 (-0.53 to 0.52)	0.33 (-0.25 to 0.92)	1.15 (0.03 to 2.27)	-0.33 (-1.03 to 0.37)	-0.03 (-0.56 to 0.49)	**Non-operative treatment**

Intervention effects expressed as standardised mean differences (SMDs) with 95% confidence intervals of late HRQoL (> 24 months). In the lower triangle (network estimates), the column-defining intervention is the reference group; a SMD with a negative value (< 0) favours the column-defining intervention for the network meta-analysis results. In the upper triangle ((direct estimates (D) and indirect estimates (I)), the row-defining intervention is the reference group; a SMD with a negative value (< 0) favours the row-defining intervention for the pair-wise meta-analysis. Blank spaces indicate that no direct estimate was available and the network estimate was derived from indirect evidence only. **HA:** hemiarthroplasty; **THA:** total hip arthroplasty

Table 12. HRQoL at 12 months: estimated probabilities of rankings

Rank	THA (single articulation)	Cemented modern bipolar HA	Uncemented modern bipolar HA	Cemented modern unipolar HA	Non-operative treatment	Screw treatment	Uncemented modern unipolar HA	Dynamic fixed angle plate
Best	36.5	19.7	27.2	7.6	6.6	0.2	2.2	0.1
2nd	24.4	32.9	19.1	13.4	6.9	0.6	2.3	0.3
3rd	19.8	26.9	18.1	21.3	8	2.5	2.9	0.5
4th	12.2	13.5	17.2	27.2	12.9	10.1	6	0.8
5th	5.4	5.3	11.1	18.8	18.8	28.2	10.7	1.8
6th	1.5	1.4	5.4	9.5	21.9	40.3	15.9	4.2
7th	0.2	0.2	1.7	2.1	19.6	17.4	39.6	19.3
Worst	0	0	0.2	0.1	5.4	0.8	20.3	73.1
MEAN RANK	**2.3**	**2.6**	**2.9**	**3.7**	**5**	**5.6**	**6.3**	**7.6**
SUCRA	**0.8**	**0.8**	**0.7**	**0.6**	**0.4**	**0.3**	**0.2**	**0.1**

Estimated probabilities of rankings, mean rank and SUCRA for each treatment in the HRQoL at 12 months network based on random-effects consistency network meta-analysis (sorted by MR from left to right). **Treatment nodes - A:** dynamic fixed angle plate;**B:** uncemented modern bipolar hemiarthroplasty; **C:** cemented modern bipolar hemiarthroplasty; **D:** uncemented modern unipolar hemiarthroplasty; **E:** total hip arthroplasty; **F:** screws; **G:** non-operative treatment; **H:** cemented modern unipolar hemiarthroplasty. **HA:** hemiarthroplasty; **SUCRA:** surface under the cumulative ranking area; **THA:** total hip arthroplasty

Table 13. Late HRQoL: estimated probabilities of rankings

Rank	THA (single articulation)	Screw treatment	Uncemented modern bipolar HA	Non-operative treatment	Cemented modern unipolar HA	Cemented modern bipolar HA	Uncemented modern unipolar HA
Best	67.1	3.5	8.9	13	7.1	0.1	0.3
2nd	19.3	24.8	19.9	18.1	16.9	0.7	0.4
3rd	7.9	34.9	24.1	19.9	10.4	2.3	0.6
4th	4	26.5	27.6	22.2	10.5	8.3	0.8

Table 13. Late HRQoL: estimated probabilities of rankings *(Continued)*

5th	1.5	9.3	17.4	18.2	19	32.3	2.2
6th	0.2	0.9	2.1	8.2	29.2	52.1	7.1
Worst	0	0	0	0.5	6.6	4.2	88.6
MEAN RANK	**1.5**	**3.2**	**3.3**	**3.4**	**4.3**	**5.5**	**6.8**
SUCRA	**0.9**	**0.6**	**0.6**	**0.6**	**0.4**	**0.3**	**0**

Estimated probabilities of rankings, mean rank and SUCRA for each treatment in the late HRQoL network based on fixed-effects consistency network meta-analysis (sorted by mean rank from left to right). **HA:** hemiarthroplasty; **SUCRA:** surface under the cumulative ranking area; **THA:** total hip arthroplasty

Table 14. Unplanned return to theatre: network estimates, direct estimates and indirect estimates

Cemented modern unipolar HA	D: 10.66 (3.85 to 29.50) I: 3.88 (2.37 to 6.36)			D: 1.56 (0.65 to 3.71) I: 1.33 (0.71 to 2.50)	D: 1.64 (0.73 to 3.65) I: 1.29 (0.65 to 2.58)	D: 1.85 (0.50 to 6.81) I: too imprecise	D: 0.70 (0.22 to 2.21) I: 0.73 (0.99 to 3.01)			D: 4.01 (1.92 to 8.39) I: 5.71 (3.31 to 9.85)	
4.63 (2.94 to 7.30)	**Dynamic fixed angle plate**			D: 0.32 (0.15 to 0.65) I: 0.30 (0.19 to 0.46)	D: 0.69 (0.32 to 1.48) I: 0.22 (0.13 to 0.35)			D: 0.77 (0.55 to 1.09) I: 1.07 (0.74 to 1.55)		D: 1.10 (0.90 to 1.34) I: 1.05 (0.72 to 1.52)	
1.36 (0.10 to 17.63)	0.29 (0.02 to 3.70)	**Unemented first-generation bipolar HA**	D: 1.42 (0.13 to 15.37) I: too imprecise								
1.92 (0.75 to 4.95)	0.41 (0.17 to 0.99)	1.39 (0.13 to 14.69)	**Unemented modern bipolar HA**	D: 0.84 (0.30 to 2.38) I: 0.56 (0.13 to 2.31)				D: 0.33 (0.01 to 8.02)		D: 2.04 (0.52 to 8.07) I: 3.08 (1.03 to 9.23)	D: 2.38 (0.62 to 9.10)

Table 14. Unplanned return to theatre: network estimates, direct estimates and indirect estimates *(Continued)*

							I: too imprecise				I: 5.43 (0.26 to 111.27)
1.40 (0.84 to 2.35)	0.30 (0.21 to 0.44)	1.01 (0.08 to 12.30)	0.73 (0.32 to 1.68)	**Cemented modern bipolar HA**			D: 0.91 (0.40 to 2.08) I: 1.08 (0.65 to 1.79)			D: 4.35 (2.67 to 7.07) I: 2.94 (1.79 to 4.83)	
1.43 (0.85 to 2.40)	0.31 (0.20 to 0.48)	1.03 (0.08 to 12.99)	0.74 (0.29 to 1.91)	1.02 (0.60 to 1.73)	**Uncemented first-generation unipolar HA**					D: 5.85 (3.47 to 9.87) I: 1.99 (1.12 to 3.55)	
1.83 (0.52 to 6.41)	0.39 (0.10 to 1.50)	1.32 (0.08 to 22.30)	0.95 (0.20 to 4.57)	1.30 (0.34 to 5.05)	1.28 (0.33 to 4.98)	**Uncemented modern unipolar HA**					
1.45 (0.87 to 2.42)	0.31 (0.22 to 0.44)	1.05 (0.08 to 13.00)	0.75 (0.31 to 1.86)	1.03 (0.67 to 1.59)	1.02 (0.60 to 1.73)	0.79 (0.21 to 3.05)	**THA (single articulation)**		D: 6.71 (0.87 to 51.77) I: 2.77 (1.86 to 4.13)	D: 3.11 (2.23 to 4.35) I: 5.49 (2.73 to 11.03)	
0.64 (0.02 to 17.67)	0.14 (0.01 to 3.73)	0.46 (0.01 to 24.26)	0.33 (0.01 to 8.02)	0.46 (0.02 to 12.22)	0.45 (0.02 to 12.39)	0.35 (0.01 to 12.08)	0.44 (0.02 to 12.02)	**Dual-mobility THA**			
4.16 (2.53 to 6.84)	0.90 (0.70 to 1.16)	3.00 (0.24 to 37.07)	2.16 (0.89 to 5.25)	2.96 (1.95 to 4.50)	2.91 (1.80 to 4.72)	2.26 (0.59 to 8.69)	2.86 (1.93 to 4.26)	6.07 (0.24 to 154.57)	**Pin treatment**	D: 1.08 (0.78 to 1.50) I: 1.42 (0.97 to 2.08)	
5.04 (3.25 to 7.82)	1.09 (0.92 to 1.29)	3.63 (0.30 to 44.42)	2.62 (1.11 to 6.16)	3.59 (2.54 to 5.08)	3.53 (2.31 to 5.39)	2.74 (0.73 to 10.32)	3.47 (2.53 to 4.76)	7.36 (0.29 to 185.72)	1.21 (0.95 to 1.55)	**Screw treatment**	D: 1.17 (0.40 to 3.42) I: 0.51 (0.02 to 14.20)

Table 14. Unplanned return to theatre: network estimates, direct estimates and indirect estimates *(Continued)*

5.41 (1.80 to 16.26)	1.17 (0.42 to 3.26)	3.90 (0.29 to 53.20)	2.81 (0.91 to 8.71)	3.85 (1.35 to 10.99)	3.79 (1.26 to 11.36)	2.95 (0.56 to 15.57)	3.73 (1.29 to 10.74)	7.91 (0.29 to 217.59)	1.30 (0.46 to 3.69)	1.07 (0.39 to 2.96)	**Non-operative treatment**

Intervention effects expressed as risk ratios (with 95% confidence intervals) of unplanned return to theatre. In the lower triangle (network estimates), the column-defining intervention is the reference group; a risk ratio lower than 1 favours the row-defining intervention for the network meta-analysis results. In the upper triangle (direct estimates (D) and indirect estimates (I)), the row-defining intervention is the reference group; a risk ratio lower than 1 favours the column-defining intervention for the pair-wise meta-analysis. Blank spaces indicate that no direct estimate was available and the network estimate was derived from indirect evidence only. **HA:** hemiarthroplasty; **THA:** total hip arthroplasty

Table 15. Unplanned return to theatre: estimated probabilities of rankings

Rank	Cemented modern unipolar HA	Dual-mobility THA	Cemented modern bipolar HA	Uncemented first-generation unipolar HA	THA (single articulation)	Uncemented first-generation bipolar HA	Uncemented modern unipolar HA	Uncemented modern bipolar HA	Pin treatment	Dynamic fixed angle plate	Non-operative treatment	Screw treatment
Best	17.8	49.9	1.2	1.4	0.9	22.2	5.9	0.6	0.0	0.0	0.0	0.0
2nd	37.0	11.4	6.4	7.1	5.3	18.7	10.2	3.9	0.0	0.0	0.1	0.0
3rd	27.6	4.0	16.1	15.7	13.3	5.7	10.1	7.3	0.0	0.0	0.1	0.0
4th	11.0	3.1	23.2	20.6	21.9	4.2	7.4	8.4	0.0	0.0	0.2	0.0
5th	4.5	2.9	24.7	20.8	23.8	3.9	8.1	10.8	0.1	0.0	0.4	0.0
6th	1.5	4.2	18.4	17.7	19.1	6.3	11.5	18.8	0.9	0.1	1.4	0.0
7th	0.4	5.1	7.8	12.1	11.5	9.1	15.7	27.9	5.3	1.2	3.6	0.1
8th	0.1	5.3	2.1	4.5	4.0	9.3	18.3	18.4	19.8	6.4	10.6	1.2
9th	0.0	1.7	0.1	0.2	0.1	3.4	4.4	2.2	42.2	22.5	17.3	5.8
10th	0.0	1.3	0.0	0.0	0.0	2.0	2.1	0.9	23.1	39.6	8.5	22.4
11th	0.0	3.0	0.0	0.0	0.0	4.6	2.8	0.6	6.6	24.8	13.5	44.2
Worst	0.0	8.0	0.0	0.0	0.0	10.6	3.3	0.2	2.0	5.3	44.3	26.3

Table 15. Unplanned return to theatre: estimated probabilities of rankings *(Continued)*

MEAN RANK	**2.5**	**3.7**	**4.6**	**4.8**	**4.9**	**5.2**	**5.8**	**6.1**	**9.1**	**10.0**	**10.4**	**10.9**
SUCRA	**0.9**	**0.8**	**0.7**	**0.7**	**0.6**	**0.6**	**0.6**	**0.5**	**0.3**	**0.2**	**0.1**	**0.1**

Estimated probabilities of rankings, mean rank and SUCRA for each treatment in the unplanned to theatre network based on random-effects consistency network meta-analysis (sorted by mean rank from left to right). **HA:** hemiarthroplasty; **SUCRA:** surface under the cumulative ranking area; **THA:** total hip arthroplasty

APPENDICES

Appendix 1. Search strategies

CENTRAL (CRS-Web)

#1 MESH DESCRIPTOR Femoral Fractures EXPLODE ALL AND CENTRAL:TARGET
#2 ((hip or hips or cervical) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#3 ((femoral* or femur* or acetabul*) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#5 ((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#6 ((head or neck or proximal) NEAR5 (fracture* or break* or broke*)) and (femoral* or femur*) AND CENTRAL:TARGET
#7 #1 OR #2 OR #3 OR #4 OR #5 OR #6 AND CENTRAL:TARGET
#8 MESH DESCRIPTOR Arthroplasty, Replacement, Hip AND CENTRAL:TARGET
#9 MESH DESCRIPTOR Hip Prosthesis AND CENTRAL:TARGET
#10 MESH DESCRIPTOR Arthroplasty, Replacement AND CENTRAL:TARGET
#11 MESH DESCRIPTOR Hemiarthroplasty AND CENTRAL:TARGET
#12 MESH DESCRIPTOR Joint Prosthesis AND CENTRAL:TARGET
#13 ((arthroplast* or hemiarthroplast*) NEAR5 (hip or hips or femur* or femoral* or acetabul*)) AND CENTRAL:TARGET
#14 ((hip or hips) NEAR5 (replac* or prosthes* or implant*)) AND CENTRAL:TARGET
#15 ((joint* NEAR5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*)) AND CENTRAL:TARGET
#16 #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 AND CENTRAL:TARGET
#17 MESH DESCRIPTOR Fractures, Bone AND CENTRAL:TARGET
#18 MESH DESCRIPTOR Fracture Dislocation EXPLODE ALL AND CENTRAL:TARGET
#19 MESH DESCRIPTOR Fractures, Closed AND CENTRAL:TARGET
#20 MESH DESCRIPTOR Fractures, Comminuted AND CENTRAL:TARGET
#21 MESH DESCRIPTOR Fractures, Compression AND CENTRAL:TARGET
#22 MESH DESCRIPTOR Fractures, Malunited AND CENTRAL:TARGET
#23 MESH DESCRIPTOR Fractures, Multiple AND CENTRAL:TARGET
#24 MESH DESCRIPTOR Fractures, Open AND CENTRAL:TARGET
#25 MESH DESCRIPTOR Fractures, Spontaneous AND CENTRAL:TARGET
#26 MESH DESCRIPTOR Fractures, Stress AND CENTRAL:TARGET
#27 MESH DESCRIPTOR Fractures, Ununited AND CENTRAL:TARGET
#28 MESH DESCRIPTOR Intra-Articular Fractures AND CENTRAL:TARGET
#29 MESH DESCRIPTOR Osteoporotic Fractures AND CENTRAL:TARGET
#30 MESH DESCRIPTOR Periprosthetic Fractures AND CENTRAL:TARGET
#31 fracture* AND CENTRAL:TARGET
#32 #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 AND CENTRAL:TARGET
#33 #32 AND #16 AND CENTRAL:TARGET
#34 (pin or pins or nail or nails or screw or screws or plate or plates) AND CENTRAL:TARGET
#35 MESH DESCRIPTOR Internal Fixators AND CENTRAL:TARGET
#36 MESH DESCRIPTOR Bone Nails AND CENTRAL:TARGET
#37 MESH DESCRIPTOR Bone Plates AND CENTRAL:TARGET
#38 MESH DESCRIPTOR Bone Screws EXPLODE ALL AND CENTRAL:TARGET
#39 (static NEXT (device* or implant*)) AND CENTRAL:TARGET
#40 (dynamic NEXT (device* or implant*)) AND CENTRAL:TARGET
#41 #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 AND CENTRAL:TARGET
#42 ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)) AND CENTRAL:TARGET
#43 (hip or hips or femur* or femoral* or acetabul*) AND CENTRAL:TARGET
#44 #43 AND (#17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30) AND CENTRAL:TARGET
#45 #42 OR #44 AND CENTRAL:TARGET
#46 #41 AND #45 AND CENTRAL:TARGET
#47 #7 OR #33 OR #46 AND CENTRAL:TARGET
#48 14/11/2018_TO_08/07/2020:CRSCREATED AND CENTRAL:TARGET
#49 #47 AND #48

MEDLINE (Ovid)

1 exp Femoral Fractures/
2 ((hip or hips or cervical) adj5 (fracture$ or break$ or broke$)).ti,ab,kf.

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

Embase (Ovid)

1 exp Femur Fractures/ or exp hip fracture/
2 ((hip or hips or cervical) adj5 (fracture$ or break$ or broke$)).ti,ab,kw.
3 ((femoral$ or femur$ or acetabul$) adj5 (fracture$ or break$ or broke$)).ti,ab,kw.
4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) adj5 (fracture $ or break$ or broke$)).ti,ab,kw.
5 ((extracapsular or extra-capsular or trochant$ or subtrochant$ or pertrochant$ or intertrochant$) adj5 (fracture$ or break$ or broke $)).ti,ab,kw.
6 (((head or neck or proximal) adj5 (fracture$ or break$ or broke$)) and (femoral$ or femur$)).ti,ab,kw.
7 or/1-6
8 exp hip surgery/ or (joint surgery/ and exp hip/)
9 exp Hip Prosthesis/
10 joint prosthesis/ and exp hip/
11 Replacement Arthroplasty/ and exp hip/
12 exp Hip arthroplasty/
13 Arthroplasty/ and exp hip/
14 Hemiarthroplasty/ and exp hip/

15 Hip hemiarthroplasty/
16 ((arthroplast$ or hemiarthroplast$) adj5 (hip or hips or femur$ or femoral$ or acetabul$)).ti,ab,kw.
17 ((hip or hips) adj5 (replac$ or prosthes$ or implant$)).ti,ab,kw.
18 ((joint$1 adj5 (replac$ or prosthes$ or implant$)) and (hip or hips or femur$ or femoral$ or acetabul$)).ti,ab,kw.
19 or/8-18
20 fracture/
21 Fracture dislocation/
22 Comminuted fracture/
23 Multiple fracture/
24 Open fracture/
25 Fragility fracture/
26 exp Fracture healing/
27 Stress fracture/
28 intraarticular fracture/
29 periprosthetic fracture/
30 fracture$.ti,ab,kw.
31 or/20-30
32 19 and 31
33 (pin or pins or nail or nails or screw or screws or plate or plates).ti,ab,kw.
34 internal fixator/ or exp bone nail/ or exp bone plate/ or exp bone pin/ or exp bone screw/ or exp femoral fixation device/
35 (static adj (device$1 or implant$1)).ti,ab,kw.
36 (dynamic adj (device$1 or implant$1)).ti,ab,kw.
37or/33-36
38 ((hip or hips or femur$ or femoral$ or acetabul$) and (fracture$ or break$ or broke$)).ti,ab,kw.
39 (hip or hips or femur$ or femoral$ or acetabul$).ti,ab,kw.
40 39 and 31
41 37 and (38 or 40)
42 7 or 32 or 41
43 Randomized controlled trial/
44 Controlled clinical study/
45 Random$.ti,ab.
46 randomization/
47 intermethod comparison/
48 placebo.ti,ab.
49 (compare or compared or comparison).ti.
50 ((evaluated or evaluate or evaluating or assessed or assess) and (compare or compared or comparing or comparison)).ab.
51 (open adj label).ti,ab.
52 ((double or single or doubly or singly) adj (blind or blinded or blindly)).ti,ab.
53 double blind procedure/
54 parallel group$1.ti,ab.
55 (crossover or cross over).ti,ab.
56 ((assign$ or match or matched or allocation) adj5 (alternate or group$1 or intervention$1 or patient$1 or subject$1 or participant $1)).ti,ab.
57 (assigned or allocated).ti,ab.
58 (controlled adj7 (study or design or trial)).ti,ab.
59 (volunteer or volunteers).ti,ab.
60 human experiment/
61 trial.ti.
62 or/43-61
63 (random$ adj sampl$ adj7 ("cross section$" or questionnaire$1 or survey$ or database$1)).ti,ab. not (comparative study/ or controlled study/ or randomi?ed controlled.ti,ab. or randomly assigned.ti,ab.)
64 Cross-sectional study/ not (randomized controlled trial/ or controlled clinical study/ or controlled study/ or randomi?ed controlled.ti,ab. or control group$1.ti,ab.)
65 (((case adj control$) and random$) not randomi?ed controlled).ti,ab.
66 (Systematic review not (trial or study)).ti.
67 (nonrandom$ not random$).ti,ab.
68 "Random field$".ti,ab.
69 (random cluster adj3 sampl$).ti,ab.
70 (review.ab. and review.pt.) not trial.ti.
71 "we searched".ab. and (review.ti. or review.pt.)
72 "update review".ab.
73 (databases adj4 searched).ab.

74 (rat or rats or mouse or mice or swine or porcine or murine or sheep or lambs or pigs or piglets or rabbit or rabbits or cat or cats or dog or dogs or cattle or bovine or monkey or monkeys or trout or marmoset$1).ti. and animal experiment/
75 Animal experiment/ not (human experiment/ or human/)
76 or/63-75
77 62 not 76
78 42 and 77

Web of Science

1 TOPIC: (((hip or hips or cervical) NEAR/5 (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
2 TOPIC: (((femoral* or femur* or acetabul*) NEAR/5 (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
3 TOPIC: (((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) NEAR/5 (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
4 TOPIC: (((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) NEAR/5 (fracture* or break* or broke*))) Indexes=SCIEXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
5 TOPIC: (((head or neck or proximal) NEAR/5 (fracture* or break* or broke*)) and (femoral* or femur*)) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
6 #5 OR #4 OR #3 OR #2 OR #1 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
7 TS=(((arthroplast* or hemiarthroplast*) NEAR/5 (hip or hips or femur* or femoral* or acetabul*)) and fracture*) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
8 TS=(((hip or hips) NEAR/5 (replac* or prosthes* or implant*)) and fracture*) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
9 TS=(((joint* NEAR/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*)) and fracture*) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
10 TS=((pin or pins or nail or nails or screw or screws or plate or plates or fixator*) and ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
11 TS=((“static device*” OR “static implant*”) and ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
12 TS=((“dynamic device*” or “dynamic implant*”) and ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
13 #12 OR #11 OR #10 OR #9 OR #8 OR #7 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
14 #13 OR #6 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
15 TS=(random* or factorial* or crossover* or "cross-over*" or placebo* or "doubl* blind*" or "singl* blind*" or assign* or allocat* or volunteer* or "trial" or "groups" or "controlled") Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
16 #15 AND #14 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
17 #16 Indexes=SCI-EXPANDED, CPCI-S Timespan=1900-2018
18 TI=(RAT OR RATS OR MOUSE OR MOUSE OR DOG OR DOGS OR RABBIT OR RABBITS OR PIG OR PIGS OR SWINE OR PORCINE) Indexes=SCIEXPANDED, CPCI-S Timespan=1900-2020
19 #17 NOT #18 Indexes=SCI-EXPANDED, CPCI-S Timespan=1900-2020

Cochrane Database of Systematic Reviews (CDSR)

#1 MeSH descriptor: [Femoral Fractures] explode all trees
#2 ((hip or hips or cervical) NEAR/5 (fracture* or break* or broke*))
#3 ((femoral* or femur* or acetabul*) NEAR/5 (fracture* or break* or broke*))
#4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) NEAR/5 (fracture* or break* or broke*))
#5 ((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) NEAR/5 (fracture* or break* or broke*))
#6 ((head or neck or proximal) NEAR/5 (fracture* or break* or broke*)) and (femoral* or femur*)
#7 #1 OR #2 OR #3 OR #4 OR #5 OR #6
#8 MeSH descriptor: [Arthroplasty, Replacement, Hip] this term only
#9 MeSH descriptor: [Hip Prosthesis] this term only
#10 MeSH descriptor: [Arthroplasty, Replacement] this term only
#11 MeSH descriptor: [Hemiarthroplasty] this term only
#12 MeSH descriptor: [Joint Prosthesis] this term only
#13 ((arthroplast* or hemiarthroplast*) NEAR/5 (hip or hips or femur* or femoral* or acetabul*))
#14 ((hip or hips) NEAR/5 (replac* or prosthes* or implant*))
#15 ((joint* NEAR/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))
#16 #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15
#17 MeSH descriptor: [Fractures, Bone] this term only
#18 MeSH descriptor: [Fracture Dislocation] explode all trees

#19 MeSH descriptor: [Fractures, Closed] this term only
#20 MeSH descriptor: [Fractures, Comminuted] this term only
#21 MeSH descriptor: [Fractures, Compression] this term only
#22 MeSH descriptor: [Fractures, Malunited] this term only
#23 MeSH descriptor: [Fractures, Multiple] this term only
#24 MeSH descriptor: [Fractures, Open] this term only
#25 MeSH descriptor: [Fractures, Spontaneous] this term only
#26 MeSH descriptor: [Fractures, Stress] explode all trees
#27 MeSH descriptor: [Fractures, Ununited] this term only
#28 MeSH descriptor: [Intra-Articular Fractures] this term only
#29 MeSH descriptor: [Osteoporotic Fractures] this term only
#30 MeSH descriptor: [Periprosthetic Fractures] this term only
#31 fracture*
#32 #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31
#33 #16 AND #32
#34 (pin or pins or nail or nails or screw or screws or plate or plates)
#35 MeSH descriptor: [Internal Fixators] this term only
#36 MeSH descriptor: [Bone Nails] this term only
#37 MeSH descriptor: [Bone Plates] this term only
#38 MeSH descriptor: [Bone Screws] explode all trees
#39 (static NEXT (device* or implant*))
#40 (dynamic NEXT (device* or implant*))
#41 #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40
#42 ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))
#43 (hip or hips or femur* or femoral* or acetabul*)
#44 #43 AND (#17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30)
#45 #42 OR #44
#46 #41 AND #45
#47 #7 OR #33 OR #46 in Cochrane Reviews

Database of Abstracts of Reviews of Effects (DARE)

1 (MeSH DESCRIPTOR Femoral Fractures EXPLODE ALL TREES)
2 ((hip or hips or cervical) near5 (fracture* or break* or broke*))
3 ((fracture* or break* or broke*) near5 (hip or hips or cervical))
4 ((femoral* or femur* or acetabul*) near5 (fracture* or break* or broke*))
5 ((fracture* or break* or broke*) near5 (femoral* or femur* or acetabul*))
6 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) near5 (fracture* or break* or broke*))
7 ((fracture* or break* or broke*) near5 (intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical))
8 ((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near5 (fracture* or break* or broke*))
9 ((fracture* or break* or broke*) near5 (extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*))
10 ((head or neck or proximal) near5 (fracture* or break* or broke*)) AND (femoral* or femur*)
11 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10
12 (MeSH DESCRIPTOR Arthroplasty, Replacement, Hip) OR (MeSH DESCRIPTOR Hip Prosthesis)
13 (MeSH DESCRIPTOR Arthroplasty, Replacement) OR (MeSH DESCRIPTOR Hemiarthroplasty) OR (MeSH DESCRIPTOR Joint Prosthesis)
14 ((arthroplast* or hemiarthroplast*) near5 (hip or hips or femur* or femoral* or acetabul*))
15 ((hip or hips or femur* or femoral* or acetabul*) near5 (arthroplast* or hemiarthroplast*))
16 ((hip or hips) near5 (replac* or prosthes* or implant*))
17 ((replac* or prosthes* or implant*) near5 (hip or hips))
18 (joint* near5 (replac* or prosthes* or implant*)) AND (hip or hips or femur* or femoral* or acetabul*)
19 #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18
20 (MeSH DESCRIPTOR fractures, bone)
21 (MeSH DESCRIPTOR fracture dislocation EXPLODE ALL TREES)
22 (MeSH DESCRIPTOR fractures, closed)
23 (MeSH DESCRIPTOR fractures, comminuted)
24 (MeSH DESCRIPTOR fractures, compression)
25 (MeSH DESCRIPTOR fractures, malunited)
26 (MeSH DESCRIPTOR fractures, open)
27 (MeSH DESCRIPTOR fractures, spontaneous)
28 (MeSH DESCRIPTOR fractures, stress EXPLODE ALL TREES)

29 (MeSH DESCRIPTOR fractures, ununited)
30 (MeSH DESCRIPTOR intra-articular fractures)
31 (MeSH DESCRIPTOR osteoporotic fractures)
32 (MeSH DESCRIPTOR periprosthetic fractures)
33 (MeSH DESCRIPTOR fractures, multiple)
34 (fracture*)
35 #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34
36 #19 AND #35
37 (pin or pins or nail or nails or screw or screws or plate or plates)
38 (MeSH DESCRIPTOR internal fixators)
39 (MeSH DESCRIPTOR bone nails)
40 (MeSH DESCRIPTOR bone plates)
41 (MeSH DESCRIPTOR bone screws EXPLODE ALL TREES)
42 (static near (device* or implant*))
43 ((device* or implant*) near static)
44 (dynamic near (device* or implant*))
45 ((device* or implant*) near dynamic)
46 #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45
47 ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))
48 (hip or hips or femur* or femoral* or acetabul*)
49 (#20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33)
50 #48 AND #49
51 #47 OR #50
52 #46 AND #51
53 #11 OR #36 OR #52
54 * IN DARE
55 #53 AND #54

Health Technology Assessment (HTA)

1 (MeSH DESCRIPTOR Femoral Fractures EXPLODE ALL TREES)
2 ((hip or hips or cervical) near5 (fracture* or break* or broke*))
3 ((fracture* or break* or broke*) near5 (hip or hips or cervical))
4 ((femoral* or femur* or acetabul*) near5 (fracture* or break* or broke*))
5 ((fracture* or break* or broke*) near5 (femoral* or femur* or acetabul*))
6 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) near5 (fracture* or break* or broke*))
7 ((fracture* or break* or broke*) near5 (intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical))
8 ((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near5 (fracture* or break* or broke*))
9 ((fracture* or break* or broke*) near5 (extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*))
10 ((head or neck or proximal) near5 (fracture* or break* or broke*)) AND (femoral* or femur*)
11 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10
12 (MeSH DESCRIPTOR Arthroplasty, Replacement, Hip) OR (MeSH DESCRIPTOR Hip Prosthesis)
13 (MeSH DESCRIPTOR Arthroplasty, Replacement) OR (MeSH DESCRIPTOR Hemiarthroplasty) OR (MeSH DESCRIPTOR Joint Prosthesis)
14 ((arthroplast* or hemiarthroplast*) near5 (hip or hips or femur* or femoral* or acetabul*))
15 ((hip or hips or femur* or femoral* or acetabul*) near5 (arthroplast* or hemiarthroplast*))
16 ((hip or hips) near5 (replac* or prosthes* or implant*))
17 ((replac* or prosthes* or implant*) near5 (hip or hips))
18 (joint* near5 (replac* or prosthes* or implant*)) AND (hip or hips or femur* or femoral* or acetabul*)
19 #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18
20 (MeSH DESCRIPTOR fractures, bone)
21 (MeSH DESCRIPTOR fracture dislocation EXPLODE ALL TREES)
22 (MeSH DESCRIPTOR fractures, closed)
23 (MeSH DESCRIPTOR fractures, comminuted)
24 (MeSH DESCRIPTOR fractures, compression)
25 (MeSH DESCRIPTOR fractures, malunited)
26 (MeSH DESCRIPTOR fractures, open)
27 (MeSH DESCRIPTOR fractures, spontaneous)
28 (MeSH DESCRIPTOR fractures, stress EXPLODE ALL TREES)
29 (MeSH DESCRIPTOR fractures, ununited)
30 (MeSH DESCRIPTOR intra-articular fractures)

31 (MeSH DESCRIPTOR osteoporotic fractures)
32 (MeSH DESCRIPTOR periprosthetic fractures)
33 (MeSH DESCRIPTOR fractures, multiple)
34 (fracture*)
35 #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34
36 #19 AND #35
37 (pin or pins or nail or nails or screw or screws or plate or plates)
38 (MeSH DESCRIPTOR internal fixators)
39 (MeSH DESCRIPTOR bone nails)
40 (MeSH DESCRIPTOR bone plates)
41 (MeSH DESCRIPTOR bone screws EXPLODE ALL TREES)
42 (static near (device* or implant*))
43 ((device* or implant*) near static)
44 (dynamic near (device* or implant*))
45 ((device* or implant*) near dynamic)
46 #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45
47 ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))
48 (hip or hips or femur* or femoral* or acetabul*)
49 (#20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33)
50 #48 AND #49
51 #47 OR #50
52 #46 AND #51
53 #11 OR #36 OR #52
54 * IN HTA
55 #53 AND #54

Epistemonikos

Search 1:
Title/abstract (fracture* or break* or broke) AND Title/abstract (hip or hips or cervical or femoral* or femur* or acetabul* or intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical or extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*)

Search 2:
Title/abstract (hip or hips or femur* or femoral* or acetabul*) and (replac* or prosthes* or implant*) and fracture*
OR Title/abstract
(arthroplast* or hemiarthroplast*) and (hip or hips or femur* or femoral* or acetabul*) and fracture*

Search 3:
Title/abstract (pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators) AND Title/abstract (hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke)

Proquest DISSERTATIONS AND THESES

S1 ti(((hip or hips or cervical) near/5 (fracture* or break* or broke*))) OR ab(((hip or hips or cervical) near/5 (fracture* or break* or broke*)))
S2 ti(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*))) OR ab(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*)))
S3 ti(((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) near/5 (fracture* or break* or broke*))) OR ab(((intracapsular or intracapsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) near/5 (fracture* or break* or broke*)))
S4 ti(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*))) OR ab(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*)))
S5 ti((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*))) OR ab((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*)))
S6 (ti(((hip or hips or cervical) near/5 (fracture* or break* or broke*))) OR ab(((hip or hips or cervical) near/5 (fracture* or break* or broke*)))) OR (ti(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*))) OR ab(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*)))) OR (ti(((intracapsular or intracapsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) near/5 (fracture* or break* or broke*))) OR ab(((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basicervical) near/5 (fracture* or break* or broke*)))) OR (ti(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*))) OR ab(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*)))) OR (ti((((head or neck or proximal) near/5

(fracture* or break* or broke*)) and (femoral* or femur*))) OR ab((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*))))
S7 ti((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*)) OR ab((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*))
S8 ti((hip or hips) near/5 (replac* or prosthes* or implant*)) OR ab((hip or hips) near/5 (replac* or prosthes* or implant*))
S9 ti(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))) OR ab(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*)))
S10 (ti((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*)) OR ab((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*))) OR (ti((hip or hips) near/5 (replac* or prosthes* or implant*)) OR ab((hip or hips) near/5 (replac* or prosthes* or implant*))) OR (ti(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))) OR ab(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))))
S11 ti(fracture*) OR ab(fracture*)
S12 ((ti((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*)) OR ab((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*))) OR (ti((hip or hips) near/5 (replac* or prosthes* or implant*)) OR ab((hip or hips) 183 near/5 (replac* or prosthes* or implant*))) OR (ti(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))) OR ab(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))))) AND (ti(fracture*) OR ab(fracture*))
S13 ti((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators)) OR ab((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators))
S14 ti(static near (device* or implant*)) OR ab(static near (device* or implant*))
S15 ti(dynamic near (device* or implant*)) OR ab(dynamic near (device* or implant*))
S16 (ti((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators)) OR ab((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators))) OR (ti(static near (device* or implant*)) OR ab(static near (device* or implant*))) OR (ti(dynamic near (device* or implant*)) OR ab(dynamic near (device* or implant*)))
S17 ti((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)) OR ab((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))
S18 ((ti((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators)) OR ab((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators))) OR (ti(static near (device* or implant*)) OR ab(static near (device* or implant*))) OR (ti(dynamic near (device* or implant*)) OR ab(dynamic near (device* or implant*)))) AND (ti((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)) OR ab((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)))
S19 ((ti(((hip or hips or cervical) near/5 (fracture* or break* or broke*))) OR ab(((hip or hips or cervical) near/5 (fracture* or break* or broke*)))) OR (ti(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*))) OR ab(((femoral* or femur* or acetabul*) near/5 (fracture* or break* or broke*)))) OR (ti(((intracapsular or intracapsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) near/5 (fracture* or break* or broke*))) OR ab(((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basicervical) near/5 (fracture* or break* or broke*)))) OR (ti(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*))) OR ab(((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) near/5 (fracture* or break* or broke*)))) OR (ti((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*))) OR ab((((head or neck or proximal) near/5 (fracture* or break* or broke*)) and (femoral* or femur*))))) OR (((ti((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*)) OR ab((arthroplast* or hemiarthroplast*) near/5 (hip or hips or femur* or femoral* or acetabul*))) OR (ti((hip or hips) near/5 (replac* or prosthes* or implant*)) OR ab((hip or hips) near/5 (replac* or prosthes* or implant*))) OR (ti(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))) OR ab(((joint* near/5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*))))) AND (ti(fracture*) OR ab(fracture*))) OR (((ti((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators)) OR ab((pin or pins or nail or nails or screw or screws or plate or plates or fixator or fixators))) OR (ti(static near (device* or implant*)) OR ab(static near (device* or implant*))) OR (ti(dynamic near (device* or implant*)) OR ab(dynamic near (device* or implant*)))) AND (ti((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)) OR ab((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*))))

National Technical Information Service (NTIS)

Title: hip fractures OR Keyword: hip fractures

Keyword: Hip AND Keyword: Bone fractures

ClinicalTrials.gov

Advanced search limited to intervention studies in Condition or disease

Interventional Studies | (fracture OR fractures OR break OR broke OR broken) AND (hip OR hips OR femoral OR femur OR acetabular OR intracapsular OR intra-capsular OR subcapital OR sub-capital OR transcervical OR trans-cervical OR basicervical OR basi-cervical)

Interventional Studies | (fracture OR fractures OR break OR broke OR broken) AND (extracapsular OR extracapsular OR trochanter OR trochanteric OR subtrochanter OR subtrochanteric OR pertrochanter OR pertochanteric OR intertrochanter OR intertochanteric)

Interventional Studies | (hip OR hips OR femur OR femoral OR acetabular) AND (replace OR replacement OR prosthesis OR prostheses OR implant OR implants) AND (fracture OR fractures OR break OR broke OR broken)

Interventional Studies | (arthroplasty OR hemiarthroplasty) AND (hip OR hips OR femur OR femoral OR acetabular) AND (fracture OR fractures OR break OR broke OR broken)

Appendix 2. Template data extraction form

Methods	*RCT or quasi-randomised; parallel design* **Review comparison group:**
Participants	**Total number of randomised participants:** **Total number of participants that completed the study:** **Inclusion criteria:** **Exclusion criteria:** **Setting:** type of setting, how many sites & country **Baseline characteristics** **Intervention group 1** (specify by name) • Age, mean (SD): (±) years • Gender, M/F: • Smoking history, n: • Medication, type, n: • BMI, mean (SD): (±) kg/m^2 • Comorbidities, type, n: • Mobility assessment/use of walking aides: • Place of residence: • Cognitive status/dementia: • ASA status, I/II/III/IV: • Preoperative waiting time, mean (SD): (±) hours • Fracture classification, undisplaced/displaced, n: • Additional information: **Intervention group 2** (specify by name) • Age, mean (SD): (±) years • Gender, M/F: • Smoking history, n: • Medication, type, n: • BMI, mean (SD): (±) kg/m^2 • Comorbidities, type, n: • Mobility assessment/use of walking aides: • Place of residence: • Cognitive status/dementia: • ASA status, I/II/III/IV: • Preoperative waiting time, mean (SD): (±) hours • Fracture classification, undisplaced/displaced, n: • Additional information: **Overall**

(Continued)

	• Age, mean (SD): (±) years • Gender, M/F: • Smoking history, n: • Medication, type, n: • BMI, mean (SD): (±) kg/m^2 • Comorbidities, type, n: • Mobility assessment/use of walking aides: • Place of residence: • Cognitive status/dementia: • ASA status, I/II/III/IV: • Preoperative waiting time, mean (SD): (±) hours • Fracture classification, undisplaced/displaced, n: • Additional information: **Note:** • *specify outcomes for which baseline data is not specified* • are prognostic variables comparable between groups?
Interventions	**General details:** to include number of clinicians (and their skills and experience), type of anaesthesia, pre- and postoperative care (e.g. use of prophylactic antibiotics or antithromboembolics), rehabilitation (e.g. time to mobilisation or weight bearing) **Intervention group 1:** type of implant (with manufacturer details), description of use; number randomised to group, number of losses (for relevant outcomes, and with reasons for losses), number analysed by review authors for each review outcome **Intervention group 2:** type of implant (with manufacturer details), description of use; number randomised to group, number of losses (for relevant outcomes, and with reasons for losses), number analysed by review authors for each review outcome **Note:** • *specify general details for which information is not reported by study authors*
Outcomes	Outcomes measured/reported by study authors: Outcomes relevant to the review: *include measurement tools and time point of measure used in review analysis* **Note:** • *specify outcome data which are not included in the review and reasons for not including these data*
Notes	**Funding/sponsor/declarations of interest:** **Study dates:**

HISTORY

Protocol first published: Issue 8, 2019

CONTRIBUTIONS OF AUTHORS

SL (systematic reviewer): sifted and identified included studies, extracted study data, interpreted the findings and drafted the review.
RM (systematic reviewer): sifted and identified included studies, extracted study data, interpreted the findings and drafted the review.
JS (statistician): prepared estimates for the networks and conducted statistical analyses according to the protocol, interpreted the findings and approved the final draft of the review.

JC (statistician): prepared estimates for the networks and conducted statistical analyses according to the protocol, interpreted the findings and approved the final draft of the review.
WE (content expert, Trauma and Orthopaedics): agreed network nodes, and reviewed and approved the final review.
XG (content expert, Trauma and Orthopaedics): interpreted the findings, drafted the review, approved the final review and is the guarantor of the content.

Editorial contributions

Faith Armitage (Copy Editor): copy-edited the review.
Liz Bickerdike (Acute and Emergency Care Network Associate Editor): advised on methodology and review content.
Mike Brown (Acute and Emergency Care Network Senior Editor): approved the final version for publication.
Maria Clarke (Information Specialist): ran literature searches and edited the search methods section.
Kerry Dwan (Statistical Editor): advised on methodology and review content.
Joanne Elliott (Managing Editor): co-ordinated the editorial process and edited the review.

Xavier Griffin and Sharon Lewis are members of the editorial base but were not involved in the editorial process or decision making for this review.

DECLARATIONS OF INTEREST

SL: none known
RM: none known
JS: none known
JC remained independent of study selection decisions for ongoing studies.
WE has an advisory role on infection control with Orthofix, Bone Support and Stryker, but this is unrelated to this review. He has no known conflicts of interest.
XG is funded by a National Institute for Health Research Clinician Scientist Grant. Further funding from industry and charitable grants are and have been made available to his institution. He has ongoing expert consultancy with several companies; none involve the development of any implant for use in hip fracture care. All decisions relating to the design, conduct, analysis, write-up and publication of research are independent of these funders. He remained independent of study selection decisions, risk of bias assessment and data extraction of any of the studies on which he is an author, co-applicant or has had an advisory role.

SOURCES OF SUPPORT

Internal sources

- No sources of support provided

External sources

- This project was supported by the National Institute for Health Research via Cochrane Infrastructure funding to the Cochrane Bone, Joint and Muscle Trauma Group, UK

  The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the Systematic Reviews Programme, NIHR, NHS or the Department of Health.
- NIHR Cochrane Infrastructure funding to the Cochrane Bone, Joint and Muscle Trauma Group, UK

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Review information

- Title: we edited the title to better reflect the older adult population included in the review.
- Review authors: three new review authors joined the review team (SL, RM, JS) and four authors left the review author team (AS, AJ, HW, JMG).

Objectives

- We edited the objectives to reflect the restriction to older adult populations.

Methods

Criteria for considering studies for this review

- Types of participants: we edited the criteria to state the inclusion of older adults (at least 60 years of age). We excluded studies in which all study participants were not representative of the general hip fracture population, and in which we expected that most hip fractures were not caused by low-energy trauma. We reported these exclusions in Excluded studies.
- Types of outcomes: we edited the time points in the review to reflect the wider variation in data in the included studies. In addition to the early data at 4 months or earlier, we added collection of data at 12 months (prioritising 12-month data, but in its absence including data after 4 months and up to 24 months) and late (after 24 months). We did not prioritise early time points when reporting results. We reported data for all three time points, and in the summary of findings tables, abstract and plain language summary, we selected the time point which yielded the most data (i.e. 12 months after surgery).

Search methods for identification of studies

- Electronic searches: we did not search the World Health Organization International Clinical Trials Registry Platform (www.who.int/ictrp/en/) because, at the time of searching, the platform was not available because of the COVID-19 pandemic. We believed that clinical trials register searches remained comprehensive because CENTRAL also includes studies from international trials registers.

Data collection and analysis

- Data extraction and management: we planned that data extraction would be completed independently by two reviewers. In practice, one author extracted data which was checked for accuracy by a second review author. We edited the data collected to describe the flow of study participants. Rather than collected "study disposition (number randomised, number by protocol, number available for analysis)", we collected "number of randomised participants, losses (and reasons for losses), and number analysed for each outcome".
- Summary measures: we were able to extract dichotomous data from all studies as number of events per arm. We did not need to use other data such as P values. We did not use 'count data' in which studies reported more than one observation during the course of follow-up.
- Relative treatment ranking: we presented SUCRA as a proportion rather than a percentage, and have edited the methods to reflect this. In addition, we also provided an estimation of mean rank for each treatment, and described this in the methods.
- Unit of analysis issues: we did not include any cluster-randomised trials in the review.
- Reports of outcomes at different time points: as described above ('Types of outcomes'), we added an additional time point for collecting data. As we believed this approach best fit the data within the studies, as well as being most clinically appropriate, we did not consider alternative methods of grouping these time points.
- Dealing with missing data: we attempted to contact study authors of recently published studies (since 2012) when we noted data were missing or not clearly reported for critical review outcomes. Most studies in the review were published more than 20 years ago and we did not expect study authors of older studies to have ready access to study data. We specified that we used the Characteristics of included studies to note when study authors reported data that we were unable to use because of an unknown number of losses or because data were reported unclearly.
- Geometry of the network: we did not present network diagrams that were coloured according to the risk of bias.
- Presentation of results: in the review, we did not present direct pairwise comparisons and assessment of between-study heterogeneity. On reflection, we believed that presentation of a network forest plot was more informative to the reader.
- For the entire network, we did not formally compare statistical heterogeneity as originally planned. Instead, we used an informal approach to compare the magnitude of heterogeneity in the networks.
- Local approaches for evaluating inconsistency: we did not use 'loop-specific' approaches to evaluate inconsistency. Instead, we only used the node-splitting (side-split) approach.
- Investigation of heterogeneity: we did not explore possible effect modifiers through network meta-regression as we found that there was insufficient variation between studies for these effect modifiers, and individual studies did not report subgroup data by these effect modifiers. Similarly, we did not attempt to run network meta-regression models to detect associations between study size and effect size as originally planned.
- Sensitivity analysis: we planned to explore the effect of excluding studies based on particular criteria. However, we did not conduct sensitivity analyses in this review. For studies at high risk of bias, we found that we had very few studies in most of the individual treatment arms such that sensitivity analysis would produce less meaningful results. Very few studies had substantial amounts of missing data, and we found insufficient variation in fracture classifications, to warrant sensitivity analysis. We no longer believed that sensitivity analysis was necessary for the time points ('early' and 'late' time points) as we had addressed this by adding a third time point. Finally, we judged that all interventions, or sufficiently similar variations of these interventions, were in clinical use in settings worldwide.
- Credibility of the evidence: we presented tables of direct, indirect and network estimates for all outcomes, but, given the number of possible direct and indirect estimates and the expected similarity in the GRADE judgements (low to very low), we did not also present GRADE judgements of certainty for each pairwise comparison. We removed this intention from the relevant section of the methods.

- Summary of findings tables: we specified the outcomes (and time points) for which we prepared summary of findings tables, the inclusion of all available interventions (from our nodes), and the decision to choose a reference comparator against which to present network estimates in the tables. We did not include ranking values in the summary of findings tables; we were advised to drop this information from the table by a Methodological Editor in the Cochrane Methods Support Unit.

NOTES

Additional figures and data are available on request from the study authors of the Cochrane Bone, Joint and Muscle Trauma Group. These include the following.

- Forest plots of direct comparisons of treatments (only studies in the networks).
- Netfunnel plots.
- Contribution matrix figures.
- Bar charts showing distribution of key baseline characteristics (gender, age, fracture displacement).
- Outcome data for all studies (included and not included in the networks).

INDEX TERMS

Medical Subject Headings (MeSH)

Bone Nails; Bone Plates; Fracture Fixation, Internal; *Hip Fractures [surgery]; Network Meta-Analysis

MeSH check words

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