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Arthroplasties for hip fracture in adults (Review)

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TABLE OF CONTENTS

[Intervention Review]

Arthroplasties for hip fracture in adults

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ABSTRACT

Background

Hip fractures are a major healthcare problem, presenting a huge challenge and burden to individuals and healthcare systems. The number of hip fractures globally is rising rapidly. The majority of hip fractures are treated surgically. This review evaluates evidence for types of arthroplasty: hemiarthroplasties (HAs), which replace part of the hip joint; and total hip arthroplasties (THAs), which replace all of it.

Objectives

To determine the effects of different designs, articulations, and fixation techniques of arthroplasties for treating hip fractures in adults.

Search methods

We searched CENTRAL, MEDLINE, Embase, seven other databases and one trials register in July 2020.

Selection criteria

We included randomised controlled trials (RCTs) and quasi-RCTs comparing different arthroplasties for treating fragility intracapsular hip fractures in older adults. We included THAs and HAs inserted with or without cement, and comparisons between different articulations, sizes, and types of prostheses. We excluded studies of people with specific pathologies other than osteoporosis and with hip fractures resulting from high-energy trauma.

Data collection and analysis

We used standard methodological procedures expected by Cochrane. We collected data for seven outcomes: activities of daily living, functional status, health-related quality of life, mobility (all early: within four months of surgery), early mortality and at 12 months after surgery, delirium, and unplanned return to theatre at the end of follow-up.

Main results

We included 58 studies (50 RCTs, 8 quasi-RCTs) with 10,654 participants with 10,662 fractures. All studies reported intracapsular fractures, except one study of extracapsular fractures. The mean age of participants in the studies ranged from 63 years to 87 years, and 71% were women.

We report here the findings of three comparisons that represent the most substantial body of evidence in the review. Other comparisons were also reported, but with many fewer participants.

All studies had unclear risks of bias in at least one domain and were at high risk of detection bias. We downgraded the certainty of many outcomes for imprecision, and for risks of bias where sensitivity analysis indicated that bias sometimes influenced the size or direction of the effect estimate.

HA: cemented versus uncemented (17 studies, 3644 participants)

There was moderate-certainty evidence of a benefit with cemented HA consistent with clinically small to large differences in health-related quality of life (HRQoL) (standardised mean difference (SMD) 0.20, 95% CI 0.07 to 0.34; 3 studies, 1122 participants), and reduction in the risk of mortality at 12 months (RR 0.86, 95% CI 0.78 to 0.96; 15 studies, 3727 participants). We found moderate-certainty evidence of little or no difference in performance of activities of daily living (ADL) (SMD -0.03, 95% CI -0.21 to 0.16; 4 studies, 1275 participants), and independent mobility (RR 1.04, 95% CI 0.95 to 1.14; 3 studies, 980 participants). We found low-certainty evidence of little or no difference in delirium (RR 1.06, 95% CI 0.55 to 2.06; 2 studies, 800 participants), early mortality (RR 0.95, 95% CI 0.80 to 1.13; 12 studies, 3136 participants) or unplanned return to theatre (RR 0.70, 95% CI 0.45 to 1.10; 6 studies, 2336 participants). For functional status, there was very low-certainty evidence showing no clinically important differences.

The risks of most adverse events were similar. However, cemented HAs led to less periprosthetic fractures intraoperatively (RR 0.20, 95% CI 0.08 to 0.46; 7 studies, 1669 participants) and postoperatively (RR 0.29, 95% CI 0.14 to 0.57; 6 studies, 2819 participants), but had a higher risk of pulmonary embolus (RR 3.56, 95% CI 1.26 to 10.11, 6 studies, 2499 participants).

Bipolar HA versus unipolar HA (13 studies, 1499 participants)

We found low-certainty evidence of little or no difference between bipolar and unipolar HAs in early mortality (RR 0.94, 95% CI 0.54 to 1.64; 4 studies, 573 participants) and 12-month mortality (RR 1.17, 95% CI 0.89 to 1.53; 8 studies, 839 participants). We are unsure of the effect for delirium, HRQoL, and unplanned return to theatre, which all indicated little or no difference between articulation, because the certainty of the evidence was very low. No studies reported on early ADL, functional status and mobility.

The overall risk of adverse events was similar. The absolute risk of dislocation was low (approximately 1.6%) and there was no evidence of any difference between treatments.

THA versus HA (17 studies, 3232 participants)

The difference in the risk of mortality at 12 months was consistent with clinically relevant benefits and harms (RR 1.00, 95% CI 0.83 to 1.22; 11 studies, 2667 participants; moderate-certainty evidence). There was no evidence of a difference in unplanned return to theatre, but this effect estimate includes clinically relevant benefits of THA (RR 0.63, 95% CI 0.37 to 1.07, favours THA; 10 studies, 2594 participants; low-certainty evidence). We found low-certainty evidence of little or no difference between THA and HA in delirium (RR 1.41, 95% CI 0.60 to 3.33; 2 studies, 357 participants), and mobility (MD -0.40, 95% CI -0.96 to 0.16, favours THA; 1 study, 83 participants). We are unsure of the effect for early functional status, ADL, HRQoL, and mortality, which indicated little or no difference between interventions, because the certainty of the evidence was very low.

The overall risks of adverse events were similar. There was an increased risk of dislocation with THA (RR 1.96, 95% CI 1.17 to 3.27; 12 studies, 2719 participants) and no evidence of a difference in deep infection.

Authors' conclusions

For people undergoing HA for intracapsular hip fracture, it is likely that a cemented prosthesis will yield an improved global outcome, particularly in terms of HRQoL and mortality. There is no evidence to suggest a bipolar HA is superior to a unipolar prosthesis. Any benefit of THA compared with hemiarthroplasty is likely to be small and not clinically appreciable. We encourage researchers to focus on alternative implants in current clinical practice, such as dual-mobility bearings, for which there is limited available evidence.

PLAIN LANGUAGE SUMMARY

Hip replacement surgery in adults

This review assessed evidence from randomised controlled trials (RCTs) and quasi-RCTs, on the benefits and harms of different types of hip replacement used to treat hip fracture in adults.

Background

A hip fracture is a break at the top of the leg bone. These types of breaks are common in older adults whose bones may be fragile because of a condition called osteoporosis. One method of treatment is to replace the broken hip with an artifical one. This can be done using a hemiarthroplasty (HA), which replaces part of the hip joint (the ball part of the joint). These replacements can be unipolar (a single artificial joint), or bipolar (with an additional joint within the HA). Alternatively, surgery may replace the whole hip joint, which also includes the socket in which the ball of the hip joint sits - this a total hip arthroplasty (THA). Both of these artificial joints can be fixed in place with or without bone cement.

Search date

We searched for RCTs (clinical studies where people are randomly assigned to treatment groups), and quasi-RCTs (in which people are put into groups by a method which is not randomised, such as date of birth or hospital record number) up to 6 July 2020.

Study characteristics

We included 58 studies, involving 10,654 adults with 10,662 hip fractures. Study participants ranged from 63 to 87 years of age, and 71% were women, which is usual for people who have this type of hip fracture.

Key results

Cemented HAs compared to uncemented HAs (17 studies, 3644 participants)

We found that cemented HAs improve health-related quality of life (HRQoL) and reduce the risk of death at 12 months after surgery. The sizes of these benefits ranged from a small to a large effect. There may be little or no difference between treatments in the ability to use the hip (functional status), but this evidence was very uncertain. Whether or not the HA is cemented probably makes little or no difference to performance in activities of daily living (ADL) or the ability to walk independently, how many people experience confusion after surgery (delirium), die within four months of surgery, or need additional surgery. Most complication risks were similar, but we noted that some risks related directly to hip replacement surgery (such as causing a break during surgery) were increased with uncemented HAs.

Bipolar HAs compared to unipolar HAs (13 studies, 1499 participants)

The type of HA probably makes little or no difference to how many people die within four months or up to 12 months after surgery, and may make little or no difference to the need for additional surgery. No studies reported four-month ADL and functional status. The evidence was very uncertain whether using a bipolar or unipolar HA makes any difference to delirium or HRQoL within four months of surgery. Again, complication risks were similar, and we found no evidence of a difference in the risk of hip dislocation.

THAs compared to HAs (17 studies, 3232 participants)

We are uncertain whether ADL, functional status, delirium, mobility, or deaths within four months or up to 12 months after surgery are different between these treatments. The evidence did not show a difference in the risk of additional surgery but we could not exclude the possibility of an important benefit of THA. Although the risk of most complications was similar, hip dislocation is increased with THA.

Certainty of the evidence

The evidence for many of the comparisons is based on only a few participants, and many studies used methods which may not be reliable. Most of the evidence for ADL, functional status, HRQoL, and independent walking was of low and very low certainty, meaning that we are not confident in the findings. We had limited confidence or were moderately confident in our other findings.

Conclusions

For people having a HA, it is likely that a cemented replacement produces a better outcome overall than an uncemented replacement. There is no evidence to suggest that a bipolar HA leads to different outcomes from a unipolar HA. The differences between a total hip replacement and partial hip replacement are small and may not be clinically important.

Summary of findings 1. Cemented versus uncemented hemiarthroplasty for hip fracture in adults

Cemented versus uncemented hemiarthroplasty for hip fracture in adults

Patient or population: adults with displaced and undisplaced hip fractures; included studies were for intracapsular fractures, except for one study of extracapsular fractures
Setting: hospitals; included studies were conducted in China, Croatia, Denmark, Italy, New Zealand, Norway, Pakistan, Slovenia, Sweden, the UK and USA
Intervention: HA fixed with cement (included studies which used unipolar or bipolar articulations)
Comparison: HA fixed without cement (included studies which used unipolar or bipolar articulations. Designs of HA in 6 studies were first-generation, and in 2 studies were unknown. We categorised them as first-generation.)

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with uncemented HA	Risk with cemented HA				
Activities in daily living, early (within 4 months): using GARS (range from 18 to 72), a social dependency scale (range of scores 1 to 9); lower values in these scales indicate more independence. Also using OARS-IADL (range from 0 to 14) and a 5-point Likert scale derived from EQ-5D; higher values in these scales indicate more independence Follow-up: time points in the included studies were at 3 months and 4 months	The mean GARS score in the uncemented group was **45.7**. The mean social mobility scale score in the uncemented group was **4.6**. The mean OARS-IADL score in the uncemented group was **3.7**. The mean Likert score in the uncemented group was **3.15.**	**SMD 0.03 lower** (0.21 lower to 0.16 higher)	-	1275 (4 studies)	⊕⊕⊕⊖ **moderate**[a]	This effect did not indicate a clinically important difference, based on a 'rule of thumb' of: 0.2 for a small difference, 0.5 for a medium difference, and 0.8 for a large difference.
Delirium (end of follow-up) Follow-up: time points in the included studies were at 12 months and 5 years	Study population 40 per 1000[b]	**42 per 1000** (22 to 82)	**RR 1.06** (0.55 to 2.06)	800 (2 studies)	⊕⊕⊖⊖ **low**[c]	
Functional status, early (within 4 months): using HHS (range from 0 to 100); higher values indicate better function Follow-up: time points in the included studies were at 6 weeks and 3 months	The mean HHS scores in the uncemented groups ranged from **62.53 to 72.1.**	**MD 3.38 higher** (0.05 higher to 6.70 higher)	-	416 (3 studies)	⊕⊖⊖⊖ **very low**[d]	This effect did not indicate a clinically important improvement (based on a MCID of 15.9 to 18 points).

						In addition, data were available in 1 study with extracapsular fractures which showed improvement with cemented HAs (MD 14.70, 95% CI 11.78 to 17.62; 85 participants). We noted that the CI in this effect may indicate a clinically important improvement with cemented HAs in extracapsular fractures (based on a MCID of 15.9 to 18 points).
HRQoL, early (within 4 months): using EQ-5D (range 0 to 1), and SF-12 (range 0 to 100); higher values indicate better quality of life. Follow-up: time points in the included studies were at 3 months and 4 months	The mean EQ-5D score in the uncemented group ranged from **0.31 to0.58**. The mean SF-12 score in the uncemented group was **33.8.**	**SMD 0.20 higher** (0.02 higher to 0.10 higher)	-	1122 (3 studies)	⊕⊕⊕⊖ **moderate**[a]	The difference between fixation techniques was compatible with no effect or a clinically important benefit of cemented HAs based on a MCID for EQ-5D of 0.07.
Mobility, early (within 4 months): able to walk outdoors using no more than 1 walking aid. Follow-up: time points in the included studies were at 3 months and 4 months	Study population 354 per 1000[b]	**369 per 1000** (227 to 404)	**RR 1.04** (0.95 to 1.14)	980 (3 studies)	⊕⊕⊕⊖ **moderate**[a]	
Mortality, early (within 4 months) Follow-up: time points in the included studies were at hospital discharge, 7 days, 6 weeks, 3 months and 4 months	Study population 143 per 1000[b]	**136 per 1000** (114 to 162)	**RR 95** (0.80 to 1.13)	3136 (12 studies)	⊕⊕⊖⊖ **low**[e]	
Mortality at 12 months Follow-up: time points in the included studies were at 12 months, 16 months, 18 months, and 24 months	Study population 283 per 1000[b]	**243 per 1000** (221 to 272)	**RR 0.86** (0.78 to 0.96)	3727 (15 studies)	⊕⊕⊕⊖ **moderate**[a]	
Unplanned return to theatre (end of follow-up)[f]	Study population		**RR 0.70** (0.45 to 1.10)	2336 (6 studies)	⊕⊕⊖⊖ **low**[g]	

Follow-up: time points in the included studies were at 12 months, 2 years and 5 years	39 per 1000[b]	**27 per 1000** (17 to 43)

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

CI: confidence interval; **EQ-5D:** EuroQoL 5 Dimensions instrument; **GARS:** Groningen Activity Restriction Scale;**HA:** hemiarthroplasty; **HRQoL:** health-related quality of life; **HHS:** Harris Hip Score; **MCID:** minimal clinically important difference; **MD:** mean difference; **OARS-IADL:** Older Americans Resources Scale of Instrumental Activities of Daily Living; **RR:** risk ratio; **SF-12:** Short-form 12; **SMD:** standardised mean difference; **THA:** total hip arthroplasty

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

[a]We downgraded by one level for study limitations because included studies had some high/unclear risks of bias.
[b]Derived from the pooled estimate of the uncemented HA group
[c]We downgraded by two levels: one level for imprecision because we noted a wide CI in the estimate, and one level for study limitations because the studies had unclear risks of bias.
[d]We downgraded by three levels: one level for imprecision because we noted a wide CI in the estimate, and two levels for study limitations because some studies had unclear risks of bias, and we found during sensitivity analyses that the estimate was influenced by these studies.
[e]Downgraded by two levels: one level for imprecision because the CI included possible benefits and possible harms, and one level for study limitations because the studies had unclear risks of bias.
[f]Some re-operations were because of infection, acetabular wear, dislocation, periprosthetic fracture or loosening. We noted that types of re-operation included replacement with THA, Girdlestone and drainage of infection.
[g]We downgraded by two levels for study limitations because some studies had unclear risks of bias and all studies were at high risk of detection bias.

Summary of findings 2. Bipolar hemiarthroplasty compared with unipolar hemiarthroplasty for hip fracture in adults

Bipolar hemiarthroplasty compared with unipolar hemiarthroplasty for hip fracture in adults

Patient or population: adults with displaced and undisplaced hip fractures

Setting: hospitals; included studies were conducted in Australia, Egypt, Finland, India, Norway, Sweden, the UK and USA
Intervention: bipolar HA. These were fixed with cement in 9 studies, without cement in 3 studies, and at the discretion of the surgeon in 1 study.
Comparison: unipolar HA. These were fixed with cement in 9 studies, without cement in 3 studies, and at the discretion of the surgeon in 1 study.

Outcomes	Anticipated absolute effects* (95% CI)	Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments

	Risk with unipolar HA	Risk with Bipolar HA				
Activities of daily living, early (within 4 months)	-	-	-	-	-	No studies reported this outcome
Early delirium Follow-up: postoperative period	Study population 31 per 1000[a]	15 per 1000 (3 to 81)	**RR 0.48** (0.09 to 2.58)	261 (1 study)	⊕⊖⊖⊖ **very low**[b]	
Functional status, early (within 4 months)	-	-	-	-	-	No studies reported this outcome
HRQoL, early (within 4 months): using EQ-5D (range 0 to 1); higher values indicate better quality of life Follow-up: 4 months	The mean EQ-5D score in the unipolar group was **0.54**	**MD 0.08 higher** (0.03 lower to 0.19 higher)	-	115 (1 study)	⊕⊖⊖⊖ **very low**[b]	
Mobility, early (within 4 months)		-		-		No studies reported this outcome
Mortality, early (within 4 months) Follow-up: time points in the included studies were during hospital stay, at 3 months and at 4 months	Study population 105 per 1000[a]	99 per 1000 (57 to 173)	**RR 0.94** (0.54 to 1.64)	573 (4 studies)	⊕⊕⊖⊖ **low**[c]	
Mortality at 12 months Follow-up: time points in the included studies were at 6 months, 12 months, 13 months, and 24 months	Study population 184 per 1000[a]	216 per 1000 (164 to 282)	**RR 1.17** (0.89 to 1.53)	839 (8 studies)	⊕⊕⊖⊖ **low**[c]	
Unplanned return to theatre (end of follow-up)[d] Follow-up: time points in the included studies were at 12 months, 24 months, 48 months, and 60 months	Study population 57 per 1000[a]	62 per 1000 (25 to 151)	**RR 1.08** (0.44 to 2.64)	532 (4 studies)	⊕⊖⊖⊖ **very low**[e]	

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

CI: confidence interval; **EQ-5D:** EuroQoL 5 Dimensions instrument; **HA:** hemiarthroplasty; **HRQoL:** health-related quality of life; **MD:** mean difference; **RR:** risk ratio; **THA:** total hip arthroplasty

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

[a]Derived from the unipolar HA group if results from a single study, or otherwise, from the pooled estimate of the unipolar group
[b]We downgraded by three levels: two levels for imprecision because the evidence included very few participants, and one level for study limitations because the included study had high and/or unclear risks of bias.
[c]We downgraded by two levels: one level for imprecision because we noted a wide CI in the effect estimate, and one level for study limitations because some of the included studies had unclear risks of bias.
[d]Some re-operations were because of dislocation, acetabular wear, pain, periprosthetic fracture or infection. We noted that types of re-operation included replacement with THA, revised HA, open reduction and drainage of infection.
[e]We downgraded by three levels: one level for imprecision, and two levels for study limitations because studies had high and unclear risks of bias, which included high risks of detection bias.

Summary of findings 3. Total hip arthroplasty compared with hemiarthroplasty for hip fracture in adults

Total hip arthroplasty compared with hemiarthroplasty for hip fracture in adults

Patient or population: adults with displaced and undisplaced hip fractures
Setting: hospitals; included studies were conducted in Canada, China, Greece, Finland, India, Italy, the Netherlands, New Zealand, Norway, South Africa, Spain, Sweden, the UK and USA
Intervention: THA
Comparison: HA (in 1 of the included studies, this was a first-generation design of HA)

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with HA	Risk with THA				
Activities of daily living, early (within 4 months): using Katz Index and an undefined measurement tool to identify people who were independent Follow-up: time points in the included studies were at 3 months and 4 months	Study population 764 per 1000[a]	787 per 1000 (695 to 901)	**RR 1.03** (0.91 to 1.18)	225 (2 studies)	⊕⊖⊖⊖ **very low**[b]	
Delirium (end of follow-up)	Study population 47 per 1000[a]	67 per 1000	**RR 1.41** (0.60 to 3.33)	357 (2 studies)	⊕⊕⊖⊖ **low**[c]	

Follow-up: time point in the included studies was 12 months		(28 to 158)				
Functional status, early (within 4 months): using HHS (range from 0 to 100) and Johansen hip score (range from 0 to 100); higher scores indicate better function Follow-up: time points in the included studies were at 3 months and 4 months	The mean HHS scores in HA groups ranged from **69 to 77.5**. The mean Johansen hip score in the HA group was **71.4.**	**SMD 0.27 higher** (0.07 higher to 0.47 higher)	-	395 (3 studies)	⊕⊖⊖⊖ **very low**[d]	There appeared to be no clinically important difference in this effect, based on a MCID for HHS of 16 to 18
HRQoL, early (within 4 months): using EQ-5D (range from 0 to 1); higher scores indicate better quality of life Follow-up: time points in the included studies were at 3 months and 4 months	The mean EQ-5D scores in the HA groups ranged from **0.61 to 0.67.**	**MD 0.03 higher** (0.06 lower to 0.12 higher)	-	279 (2 studies)	⊕⊖⊖⊖ **very low**[e]	Compatible with no effect or a clinically important benefit of THA, based on a MCID for EQ-5D of 0.07
Mobility, early (within 4 months): using a 9-point mobility scale; lower scores indicate better mobility Follow-up: time point in the included study was 3 months	The mean mobility score in the HA group was 3.8	**MD 0.40 lower** (0.96 lower to 0.16 higher)	-	83 (1 study)	⊕⊕⊖⊖ **low**[f]	
Mortality, early (within 4 months) Follow-up: time points in the included studies were at 1 week, 1 month, 2 months, and 4 months	Study population 62 per 1000[a]	48 per 1000 (26 to 89)	**RR 0.77** (0.42 to 1.42)	725 (6 studies)	⊕⊖⊖⊖ **very low**[g]	
Mortality at 12 months Follow-up: time points in the included studies were at 12 months and 24 months	Study population 135 per 1000[a]	135 per 1000 (112 to 165)	**RR 1.00** (0.82 to 1.34)	2667 (11 studies)	⊕⊕⊕⊖ **moderate**[h]	
Unplanned return to theatre (end of follow-up)[i] Follow-up: time points in the included studies were at 12 months, 24 months, 48 months, 60 months, and 13 years	Study population 84 per 1000[a]	57 per 1000 (35 to 97)	**RR 0.68** (0.41 to 1.15)	2476 (9 studies)	⊕⊕⊖⊖ **low**[j]	

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

CI: confidence interval; **EQ-5D:** EuroQoL 5 Dimensions instrument; **HA:** hemiarthroplasty; **HHS:** Harris Hip Score; **MCID:** minimal clinically important difference; **RR:** risk ratio; **THA:** total hip arthroplasty

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

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[a]Derived from the pooled estimate of the HA group
[b]We downgraded by three levels: one level for imprecision because the evidence included very few participants, and two levels for study limitations because one of the studies had unclear risk of selection bias and we found during sensitivity analyses that this may influence the estimate.
[c]We downgraded by two levels: one level for imprecision because we noted a wide CI in the effect, and one level for study limitations because of unclear risks of bias.
[d]We downgraded by three levels: one level for imprecision because the evidence included few participants, and two levels for study limitations because some studies had high and unclear risks of bias and we found during sensitivity analysis that the direction of effect was influenced by these studies.
[e]We downgraded by three levels: two levels for imprecision because the evidence was compatible with no difference and a clinically meaningful difference (based on a MCID for EQ-5D of 0.07), and one level for study limitations because studies had high and unclear risks of bias.
[f]We downgraded by two levels: one level for imprecision because the evidence included few participants, and one level for study limitations because the study included unclear risks of bias.
[g]We downgraded by three levels: two levels for imprecision because the evidence was consistent with both benefits and harms, and one level for study limitations because some included studies had high and unclear risks of bias.
[h]We downgraded by one level for study limitations because included studies were at high or unclear risks of bias.
[i]Some re-operations were because of dislocation, acetabular wear, pain, periprosthetic fracture or infection. We noted that types of re-operation included replacement with THA, open reduction, and internal fixation.
[j]We downgraded by two levels: one level for imprecision because the evidence was consistent with both benefits and harms, and one level for study limitations because included studies had high and unclear risks of bias which included high risks of detection bias.

BACKGROUND

Description of the condition

Epidemiology

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

Hip fractures are a major healthcare problem at the individual and population level, and present a huge challenge and burden to individuals, healthcare systems, and societies. The increased proportion of older adults in the world population means that the absolute number of hip fractures is rising rapidly worldwide. For example, in 2016 there were 65,645 new presentations of hip fracture to 177 trauma units in England, Wales, and Northern Ireland (NHFD 2017). Based on mid-2016 population estimates for these regions, this equates to an incidence rate of 108 cases per 100,000 population (ONS 2018). By 2050, the annual worldwide incidence is estimated to be 6 million hip fractures (Cooper 2011; Johnell 2004). Incident hip fracture rates are higher in high-income countries compared to low- or middle-income countries. The highest hip fracture rates are seen across northern Europe and the USA, and the lowest in Latin America and Africa (Dhanwal 2011). There is also a north-south gradient seen in European studies, and similarly, more fractures are seen in the north of the USA than in the south (Dhanwal 2011). The factors responsible for the variation in the incidence of hip fractures and osteoporosis are thought to be population demographics (with more elderly populations in countries with higher incidence rates), and the influence of ethnicity, latitude, and environmental factors such as socioeconomic deprivation (Bardsley 2013; Cooper 2011; Dhanwal 2011; Kanis 2012).

Burden of disease

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

The direct economic burden of hip fractures is also substantial. Hip fractures are among the most expensive conditions seen in hospitals, with an aggregated cost of nearly 4900 million US dollars (USD) for 316,000 inpatient episodes in the USA in 2011 (Torio 2013). 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 (NHS) and social care 1000 million pounds sterling (GBP) (NHFD 2017). Combined health and social care costs incurred during the first year following a hip fracture have been estimated at USD 43,669, which is greater than the cost for non-communicable diseases, such as acute coronary syndrome (USD 32,345) and ischaemic stroke (USD 34,772) (Williamson 2017). In established market economies, hip fractures represent 1.4% of the total healthcare burden (Johnell 2004).

Types of hip fracture

Hip fractures either involve the region of the femur that is enveloped by the ligamentous hip joint capsule (intracapsular), or that is outside the capsule (extracapsular).

Intracapsular fractures include subcapital (immediately below the femoral head), transcervical (across the mid-femoral neck), or basicervical (across the base of the femoral neck). These injuries are also commonly termed fractures of the 'neck of femur' (Lloyd-Jones 2015). Intracapsular fractures can be further subdivided by fracture morphology using several different classification systems, such as the Garden (Garden 1961) or Pauwels classifications (Pauwels 1935). The reliability of these various classifications is poor (Parker 1993a; Parker 1998). A more appropriate grouping distinguishes only those fractures that are displaced, where the anatomy of the bone has been disrupted at the fracture site, and those that 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. More recently, this classification has been refined with additional consideration of posterior tilt - this is not a component of earlier classification, but may be useful in predicting poor outcomes from osteosynthesis (Palm 2009). 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).

Extracapsular fractures traverse the femur within the area of bone bounded by the intertrochanteric line proximally up to a distance of 5 cm from the distal part of the lesser trochanter. Several classification methods have been proposed to define different types of extracapsular fractures (AO Foundation 2018; Evans 1949; Jensen 1980). They are generally subdivided depending on their relationship to the greater and lesser trochanters, the two bony projections present at the upper end of the femur, and the complexity of the fracture configuration. It is increasingly clear that each of these classifications is limited in its generalisability

since inter- and intra-observer agreement is poor. Table 1 provides a description of the most recent classification of trochanteric fractures (AO Foundation 2018). For this Cochrane Review, we plan to use a pragmatic simplification of these classifications as follows.

- Trochanteric fractures: those that lie mostly between the intertrochanteric line and a transverse line at the level of the lesser trochanter. These can be further divided into simple two-part stable fractures and comminuted or reverse obliquity unstable fractures.
- Subtrochanteric fractures: those that mostly lie in the region bordered by the lesser trochanter and 5 cm distal to the lesser trochanter.

Approximately 40% of hip fractures are extracapsular, of which 90% are trochanteric and 10% are subtrochanteric (NHFD 2017).

Description of the intervention

Internationally, many guidelines exist concerning hip fracture management (e.g. AAOS 2014; NICE 2011; SIGN 2009). Each recommends that early surgical management, generally within 24 to 48 hours, is the mainstay of care for most hip fractures. The overall goal of surgery in the older population is to facilitate early rehabilitation, enabling 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). A proposed grouping of arthroplasty interventions is given in Table 2.

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 (HA) where only the femoral head and neck are replaced, and total hip arthroplasty (THA) 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 HA can be broadly divided into two groups: unipolar and bipolar. In unipolar HAs, the femoral head is a solid block of metal. Bipolar femoral heads include a single articulation that 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 HA 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 polymethylmethacrylate bone cement. They were therefore originally inserted as a 'press fit'. The Moore prosthesis has a square femoral stem, which is fenestrated and has a shoulder to enable stabilisation within the femur; this 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 HAs exist, based on stems that have been used for THAs.

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 between 22 mm and 36 mm 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 intraprosthetic 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 arthroplasty

Total hip arthroplasty (also known as total hip replacement) involves the replacement of the acetabulum in addition to the femoral head. The first successful THA was developed by John Charnley, using metal alloy femoral heads articulating with polyethylene acetabular components. Subsequently, the articulating materials have diversified, and 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

Polymethylmethacrylate bone cement may be inserted at the time of surgery. It sets hard and acts as a grout between the prosthesis and the bone at the time of surgery. Potential advantages of cement are a reduced risk of intraoperative fracture, later periprosthetic fracture, and not relying on integration of the prosthesis with osteoporotic bone. Major side effects of cement are cardiac arrhythmias and cardiorespiratory collapse, which occasionally occur following its insertion. These complications may be fatal, leading either to 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 general complications of both types of arthroplasty are those general to surgical management of hip fracture - namely, pneumonia, venous thromboembolism, infection, acute coronary syndrome, and cerebrovascular accident - and those specific to arthroplasty, including dislocation of the prosthesis, loosening of the components, acetabular wear, and periprosthetic fracture.

Why it is important to do this review

This review replaces the Cochrane Review, Parker 2010a, on the same topic. We used up-to-date review methods and have optimised current relevance in terms of patient population,

implants used, and outcomes for policymaking bodies, such as the National Institute for Health and Care Excellence (NICE) in the UK, as well as international audiences. Since Parker 2010a, clinical uncertainty remains as to the optimum implant for older adults. Moreover, further studies have been reported since the last literature search in September 2009.

Appraisal and synthesis of contemporary evidence may enable more robust conclusions to be made to better inform practice. Furthermore, for displaced intracapsular fractures, the recommended treatment is either HA or THA (Parker 2010a; Hopley 2010; NICE 2011). However, there is a lack of evidence regarding whether older adults experience better outcomes with THA or HA. Recent research has also found interhospital variation and systematic inequalities in the provision of THA (Perry 2016). Further evidence is necessary to verify which individuals gain the most from THA. For treatment of undisplaced intracapsular fractures, there is also a gap in the evidence that resulted in the recently updated NICE guideline being unable to make an evidence-based recommendation on the best surgical management strategy (NICE 2011). Other reviews that will address other types of interventions are in preparation; we focus on arthroplasty in this review.

OBJECTIVES

To determine the effects of different designs, articulations, and fixation techniques of arthroplasties for treating hip fractures in older adults.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) and quasi-RCTs that assessed surgical interventions for the management of people with hip fracture. Quasi-RCTs are trials in which the methods of allocating people to a trial are not properly random, but are intended to produce similar groups (Cochrane 2018). We included trials published as conference abstracts, provided the trial authors reported sufficient data relating to the methods and outcomes of interest. We aimed to include unpublished data if identified in the searches.

Types of participants

We included adults undergoing surgery in a hospital setting for fragility (low-energy trauma) hip fractures. We included displaced and undisplaced intracapsular or extracapsular fractures which we expected to be caused by low-energy trauma.

We expected trial populations to have a mean age of between 80 to 85 years, and include 70% women, 30% with chronic cognitive impairment, and 50% with an American Society of Anesthesiologists (ASA) score greater than II, indicating that people may have a disease or condition affecting their fitness before surgery (NHFD 2017; NICE 2011). These characteristics would be representative of the general hip fracture population.

We excluded studies that focused exclusively on the treatment of participants: younger than 16 year of age; with fractures caused by specific pathologies other than osteoporosis; and with high-energy traumas. 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 participants with standard fragility fractures were most likely to outnumber those with high-energy trauma or local pathological fractures; therefore, the results will be generalisable to the fragility fracture population. If the data were reported separately for standard fragility fractures, we planned to use this subgroup data in our main analysis.

We did not pool studies in which the fracture type is mixed (intracapsular and extracapsular).

Types of interventions

We included all hip prostheses: unipolar HA, bipolar HA, or THA (small and large head), applied with or without cement. We included the following comparisons in the review.

- Prostheses inserted with cement versus without cement (stratified by THA versus HA; HA group subgrouped by modern versus first-generation uncemented stems).
- Bipolar HA versus unipolar HA (subgrouped by cemented versus uncemented).
- HAs versus other HAs (subgrouped by modern stem design ('ODEP 3A rating') and first-generation stem design (e.g. Austin-Moore or Thompson).
- THA versus HA (cemented or uncemented, subgrouped by old versus new, as described above);
- Single versus multiple (dual/triple) articulations of THA.
- Large-head THA (36 mm diameter or larger) versus other arthroplasty (stratified by THA versus HA).

We created a detailed table of interventions, grouping them by characteristics, and indicating which are in worldwide use. We prepared this table for the protocol with clinical authors and with the International Fragility Fracture Network (www.fragilityfracturenetwork.org/), and we updated it during review preparation to include all implants used in the included studies (Table 2).

Types of outcome measures

Depending on the length of follow-up reported, we categorised the endpoints for outcomes into 'early' (up to and including 4 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, up to the end of study follow-up). We selected four months as the definition of 'early' because most of early recovery has been achieved at this time point (Griffin 2015). This decision is also in accordance with the core outcome set for hip fracture, which prioritises early outcome over late recovery (Haywood 2014). Although priority was given to early outcomes in the presentation of our data, we also included outcome data at the '12 months' and 'late' times points.

Critical outcomes

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

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

- Delirium using recognised assessment scores, such as Mini-Mental State Examination (MMSE) mental test score and the four 'A's test (4AT).
- Functional status (region-specific) (e.g. hip rating questionnaire, Harris Hip Score, Oxford Hip Score).
- Health-related Quality of Life (HRQoL) (e.g. Short Form Health Survey (SF-36), EuroQol-5 Dimensions (EQ-5D)).
- Mobility (e.g. indoor/outdoor walking status, Cumulated Ambulation Score, Elderly Mobility Scale Score, Timed Up and Go (TUG) test, Short Physical Performance Battery, self-reported walking scores (e.g. Mobility Assessment Tool - short form)).
- Mortality.
- Unplanned return to theatre: secondary procedure required for a complication resulting directly or indirectly from the index operation or primary procedure.

Other important outcomes

We also reported the following 'important' outcomes.

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

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

Related

- Damage to a nerve, tendon, or blood vessel.
- Intraoperative periprosthetic fracture.
- Postoperative periprosthetic fracture.
- Loosening of prosthesis.
- Wound infection. We used study authors' definitions, which often distinguished deep infection and superficial infection.
- Dislocation.

Unrelated

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

Search methods for identification of studies

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. We ran the initial searches in November and December 2018, and a top-up search in July 2020 in all databases except for DARE and HTA, in which no new records had 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 these conference abstracts 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.

To identify further studies, we screened the reference lists of studies included in Parker 2010a as well as the reference lists of eligible studies and systematic reviews published within the last five years that were retrieved by the searches.

Data collection and analysis

In order to reduce bias, we ensured that any review author who is a co-applicant, 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 independently 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 against the eligibility criteria described in Criteria for considering studies for this review. We conducted full-text screening using Covidence. We resolved disagreements through discussion or by adjudication of 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). We reported in the review 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. We designed a data extraction form that aligns with the default headings in the Characteristics of included studies (see Appendix 2). Two review authors independently piloted the form on five studies and compared results. We then made changes to the template following additional discussion with the review 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; numbers 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 displacement).
- Interventions: details of each intervention (number and type, manufacturer details); general surgical details (number of clinicians and their skills and experience, perioperative care such as use of prophylactic antibiotics or antithromboembolics, mobilisation or weight-bearing protocols).
- Outcomes: all outcomes measured or reported by study authors; outcomes relevant to the review (including measurement tools and time points of measure); extraction of outcome data into data and analysis tables or additional tables in Review Manager 2014.

Assessment of risk of bias in included studies

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

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

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

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

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

Unit of analysis issues

In preparation of the review, we encountered potential unit of analysis issues. We found that some studies reported number of hip fractures (or cases) as well as the number of participants,

with a very small number of participants having two fractured hips. Often, differentiating the denominators within a report was challenging. In such studies, depending on the outcome, the unit of analysis was either the participant (for example, for outcomes such as mortality, discharge destination, or some adverse events), or the case (for example, for outcomes such as unplanned return to theatre). We noted this differentiation where applicable and used the unit of analysis (participants or case) that was appropriate for the outcome within these studies. One study included three intervention groups (Dorr 1986). We created a pairwise comparison by combining the data for the two HA groups (cemented and uncemented) and comparing these data with the THA group. Although the review included a comparison of cemented HA versus uncemented HA, we did not use data from these two study arms in this comparison because recruitment to these two groups was completed at different time points within the study period and thus it was not appropriate to compare these against one another.

Dealing with missing data

For each included study, we recorded the number of participant losses for each outcome. Unless reported otherwise, we assumed complete case data for mortality, unplanned return to theatre, and adverse events. For outcomes that required participant assessment at end of follow-up (such as 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 were not sufficiently balanced between intervention groups. If we included a study with high attrition bias, we explored the effect during sensitivity analysis. We completed sensitivity analysis only for critical review outcomes and only considered attrition for outcomes that may be affected by these losses.

We attempted to contact study authors of more recently published trials when we noted that data for critical outcomes appeared to be measured but not reported. Where standard deviations were not reported, we attempted to determine these from other reported data (such as standard errors, confidence intervals, or exact P values). We noted in the Characteristics of included studies when we could not use outcome data because they were insufficiently reported or because numbers of losses in each group were not clearly specified.

Assessment of heterogeneity

We used the I^2 statistic, automatically calculated in Review Manager 2014 software, to quantify the possible degree of heterogeneity of treatment effects between trials. We assumed moderate heterogeneity when the I^2 was between 30% and 60%; substantial heterogeneity when it was between 50% and 90%; and considerable heterogeneity when it was between 75% and 100%. We noted the importance of I^2 depending on: 1) magnitude and direction of effects; and 2) strength of evidence for heterogeneity. We did not have sufficient studies to investigate statistical heterogeneity (Deeks 2017).

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

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

Assessment of reporting biases

We planned to investigate the potential for publication bias and explore possible small-study biases using funnel plots. However, we had insufficient studies (fewer than 10 studies) for most outcomes (Sterne 2017). For outcomes with 10 or more studies, we constructed a funnel plot and interpreted the plot using a visual inspection and the Harbord modified test in Stata; for the critical review outcomes, we reported P values for the Harbord modified test. We incorporated this judgement into the assessment of publication bias within the GRADE assessment.

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

Data synthesis

We conducted meta-analyses only when meaningful; that is, when the treatments, participants, and the underlying clinical question were similar enough for pooling to make sense. We pooled results of comparable groups of trials using random-effects models. We chose this model after careful consideration of the extent to which any underlying effect could truly be thought to be fixed, given the complexity of the interventions included in this review. We presented 95% CIs throughout. We found that some studies reported outcome data at more than one time point and we reported the data within three time point windows for these studies. Early data included data up to four months, with priority given to data closest to four months; 12-month data included a window from later than four months up to 24 months, but with priority given to data at 12 months; and late data, which included data reported after 24 months at the latest time point reported by study authors. For studies that reported outcome data using more than one measurement tool, we selected the tool that was used most commonly by other studies in the comparison group, or which reported data for the largest number of participants.

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

If effect sizes were statistically significant, we considered whether the effect was clinically important. We based these decisions on

established minimal clinically important differences (MCIDs) for the measurement tool, or used Cohen's effect sizes as a guide if MCIDs were unavailable (Schünemann 2019a).

Subgroup analysis and investigation of heterogeneity

Few outcomes provided evidence from at least 10 studies to justify subgroup analysis. Although we aimed to explore possible sources of heterogeneity between studies (key effect modifiers such as age, gender, cognitive impairment, and fracture displacement and location), these possible effect modifiers were insufficiently reported to allow for meaningful subgroup analysis.

We planned to subgroup prostheses according to whether a modern or first-generation uncemented stem was used (see Types of interventions), and we reported the test for subgroup differences in outcomes that had at least 10 studies.

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

Sensitivity analysis

We used sensitivity analysis to explore the effects of risks of bias on the review's critical outcomes. If pooled analyses had at least two studies, we excluded studies that were:

- at high or unclear risk of selection bias for sequence generation (this included studies described as quasi-randomised, or those that did not adequately describe methods used to randomise participants to intervention groups); or
- at high risk of attrition bias (because studies reported a large number of losses that were unexplained or not justified for this population, or losses that were unbalanced between groups, and that we expected could influence outcome data).

We compared the effect estimates in the sensitivity analysis with the effect estimates in the primary analysis, and we reported the effect estimates from sensitivity analyses only if we noted a difference in our interpretation of the effect. We planned to conduct sensitivity analysis by excluding studies that had mixed populations, but these data were inadequately reported by study authors and did not allow for meaningful analysis. We also planned, but did not conduct, sensitivity analysis by excluding studies of interventions that are not currently in clinical use. We obtained the general view that all interventions at the major-grouping level (implant sub-category level in Table 2) remain in current use. Although some types of implant may no longer be manufactured, we believe the distinction between implants within the same category is marginal and that sensitivity analysis would not be meaningful.

Summary of findings and assessment of the certainty of the evidence

Two review authors used the GRADE system to assess the certainty of the body of evidence associated with the seven critical outcomes in the review (Schünemann 2019b):

- activities of daily living (ADL);
- delirium;
- functional status;
- health-related quality of life (HRQoL);
- mobility;
- mortality (measured within four months of surgery, and at 12 months);
- unplanned return to theatre.

For outcomes that were reported using more than one measurement tool, and that could not be combined in analysis, we assessed the certainty of the evidence for the outcome that used a measurement tool with the most participants.

The GRADE approach assesses the certainty of a body of evidence based on the extent to which we can be confident that an estimate of effect or association reflects the item being assessed. Evaluation of the certainty of a body of evidence considers within-study risk of bias (study limitations), directness of the evidence (indirectness), heterogeneity of the data (inconsistency), precision of the effect estimates (imprecision), and risk of publication bias. The certainty of the evidence could be high, moderate, low or very low, being downgraded by one or two levels depending on the presence and extent of concerns in each of the five GRADE domains. We used footnotes to describe reasons for downgrading the certainty of the evidence for each outcome, and we used these judgements when drawing conclusions in the review.

We did not construct summary of findings tables for all comparisons in this review. Instead, we selected three comparisons that provided the most substantial body of evidence. These provided evidence for each of our comparison types in our review objectives (different fixation techniques, different articulations, and different designs). We therefore constructed summary of findings tables for the following comparisons in this review, using the GRADE profiler software (GRADEpro GDT).

- Cemented HA versus uncemented HA.
- Bipolar HA versus unipolar HA.
- THA versus HA.

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 the 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 1135 records and selected 58 studies (with 101 records) for inclusion in this review. We linked any references pertaining to the same study under a single study ID. We excluded 1023 records, and report the details of eight key studies from these excluded records. Four studies are awaiting classification, and we identified seven ongoing studies. See Figure 1.

Figure 1. PRISMA flow diagram

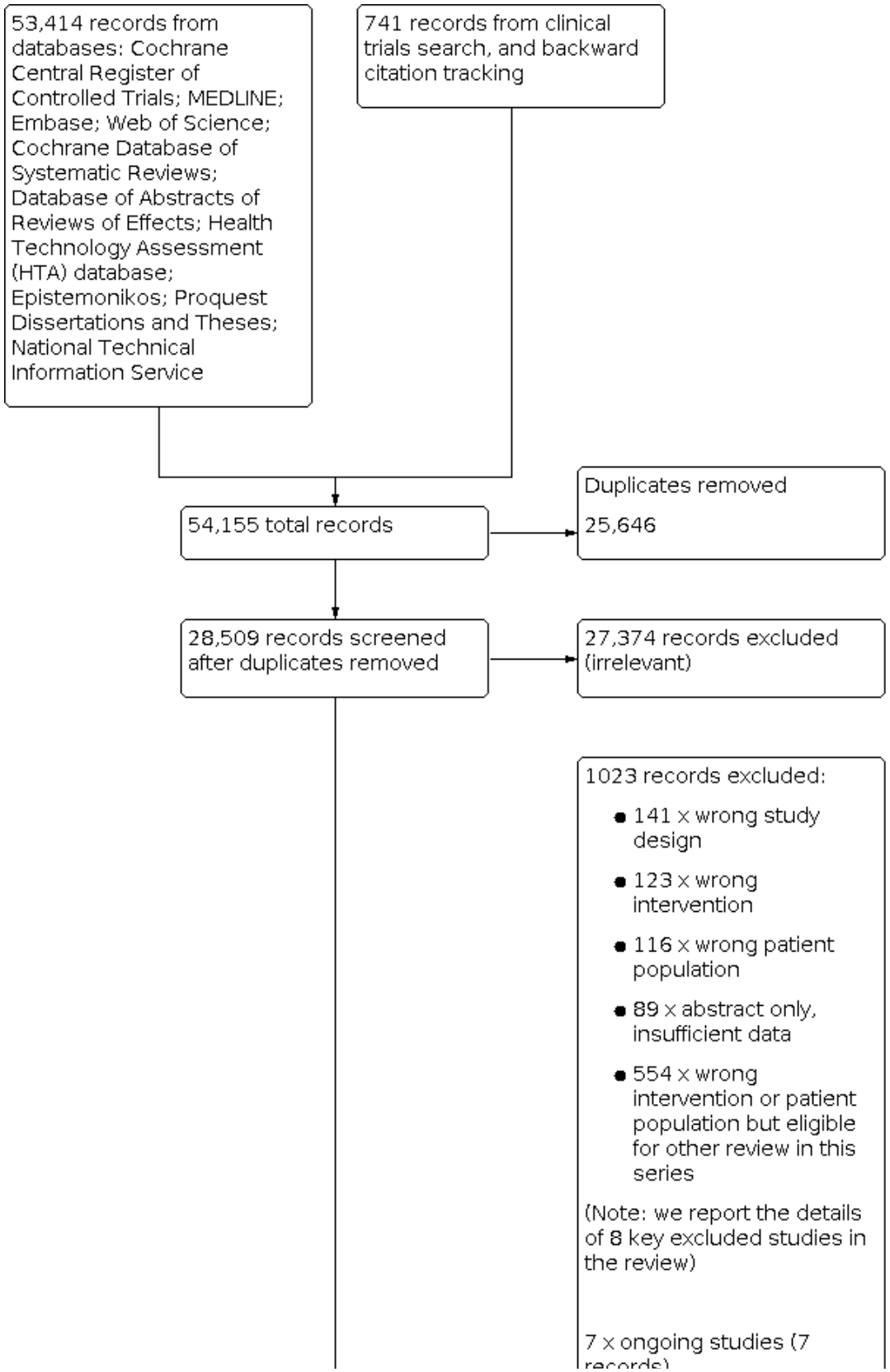
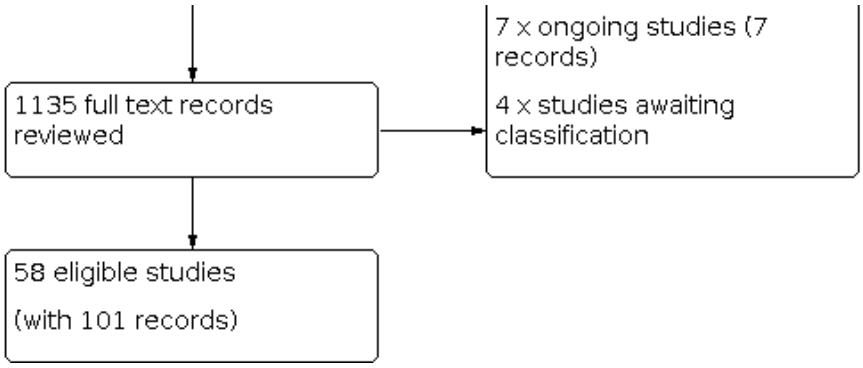


Figure 1. (Continued)



Included studies

See Characteristics of included studies. Two studies were reported only as abstracts with limited study characteristics (Moroni 2002; Patel 2008).

Types of studies and setting

Whilst most studies were RCTs, eight studies used methods to allocate participants to interventions which we assessed as quasi-randomised (Abdelkhalek 2011; Dorr 1986; Iorio 2019; Livesley 1993; Ravikumar 2000; Santini 2005; Sonaje 2017; Stoffel 2013).

Eleven were multicentre studies, and the remainder were single centre studies. Eighteen studies were completed in the UK (Baker 2006; Brandfoot 2000; Calder 1995; Calder 1996; Davison 2001; Emery 1991; Fernandez 2022; Griffin 2016; Harper 1994; Keating 2006; Livesley 1993; Parker 2010c; Parker 2012; Parker 2019; Parker 2020; Ravikumar 2000; Sadr 1977; Sims 2018), six in Sweden (Blomfeldt 2007; Chammout 2017; Chammout 2019; Cornell 1998; Hedbeck 2011; Inngul 2015), four in South Asia (Malhotra 1995; Rehman 2014; Sharma 2016; Sonaje 2017), four in Italy (Cadossi 2013; Iorio 2019; Moroni 2002; Santini 2005), four in the USA (DeAngelis 2012; Dorr 1986; Macaulay 2008; Raia 2003), three in Norway (Figved 2009; Figved 2018; Talsnes 2013), three in China (Cao 2017; Ren 2017; Xu 2017), three in Australasia (Jeffcote 2010; Stoffel 2013; Taylor 2012), two in the Netherlands (Moerman 2017; Van den Bekerom 2010), two in Egypt (Abdelkhalek 2011; Rashed 2020), and two in South Korea (Kim 2012; Lim 2020). HEALTH 2019 was an international study conducted in Canada, Finland, the Netherlands, New Zealand, Norway, South Africa, Spain, the UK, and the USA. The remainder were conducted in other European countries (Kanto 2014; Mouzopoulos 2008; Movrin 2020; Sonne-Holm 1982; Vidovic 2013), and one study did not report where the study was conducted (Patel 2008).

Studies were published between 1977 and 2020, and we include one study that we expect to be published in 2021. Approximately two-thirds of the studies were published since 2010.

Types of participants

In total, 10,654 participants, with 10,662 hip fractures, were recruited across the 58 studies. All studies included only participants with intracapsular fractures, except for Cao 2017 (85 participants), which included only participants with extracapsular fractures. Blomfeldt 2007 is the only study to report the inclusion of undisplaced fractures, which was only 2% of the reported study population. Nine studies did not report whether the fracture was displaced (Cadossi 2013; Cao 2017; Dorr 1986; Malhotra 1995; Moroni 2002; Patel 2008; Santini 2005; Sonne-Holm 1982; Xu 2017), and the remainder included displaced fractures only. One study recruited participants that had neglected fractures, more than 30 days old (Xu 2017).

Most studies specified a lower age limit for recruited participants of at least 50 years (HEALTH 2019; Macaulay 2008), 55 years (DeAngelis 2012; Dorr 1986; Rashed 2020), 60 years (Baker 2006; Fernandez 2022; Griffin 2016; Iorio 2019; Jeffcote 2010; Parker 2010c; Parker 2019; Rehman 2014; Sharma 2016; Sims 2018; Sonaje 2017; Xu 2017), 65 years (Cao 2017; Chammout 2017; Cornell 1998; Davison 2001; Kanto 2014; Lim 2020; Raia 2003; Ravikumar 2000; Santini 2005), 70 years (Blomfeldt 2007; Cadossi 2013; Figved 2009; Figved 2018; Moerman 2017; Patel 2008; Sonne-Holm 1982; Taylor 2012; Van den Bekerom 2010; Vidovic 2013), 75 years (Moroni 2002; Movrin 2020; Talsnes 2013), and 80 years (Calder 1996; Chammout 2019; Hedbeck 2011; Inngul 2015). Only five studies applied an upper age limit, which was 79 years (Calder 1995; Chammout 2017; Davison 2001), 80 years (Rashed 2020), and 90 years (Blomfeldt 2007). Where reported, the mean ages of participants ranged from 63 years to 87 years.

Seven studies did not report the baseline sex of the participants (Griffin 2016; Livesley 1993; Patel 2008; Ravikumar 2000; Sonaje 2017; Sonne-Holm 1982; Stoffel 2013). In studies that reported sex distribution, there were 6835 female participants, which represented 71% of the sample in these studies. Approximately one third of the studies specified the ability to walk prior to surgery as an inclusion criteria or required participants to be free of any cognitive impairment. Almost half of the studies stated that pathological fractures would not be included.

The mean follow-up time period was 24.3 (SD ± 109) months, with a range from 1 week (Malhotra 1995), to 13 years (Ravikumar 2000).

Types of interventions

We included 21 studies with 4282 participants that compared prostheses that were cemented or uncemented; as part of treatment with a THA (Chammout 2017), a HA (Brandfoot 2000; Cao 2017; DeAngelis 2012; Emery 1991; Fernandez 2022; Figved 2009; Harper 1994; Moerman 2017; Movrin 2020; Parker 2010c; Parker 2020; Rehman 2014; Sadr 1977; Santini 2005; Sonne-Holm 1982; Talsnes 2013; Taylor 2012; Vidovic 2013), or a mixture of either a THA or HA (Inngul 2015; Moroni 2002). We briefly summarise the characteristics of these studies and the critical review outcomes they report that are relevant to this review in Table 3.

We included 13 studies with 1499 participants that compared a bipolar HA with a unipolar HA (Abdelkhalek 2011; Calder 1995; Calder 1996; Cornell 1998; Davison 2001; Figved 2018; Hedbeck 2011; Jeffcote 2010; Kanto 2014; Malhotra 1995; Patel 2008; Raia 2003; Stoffel 2013). We briefly summarise the characteristics of these studies and the outcomes they report that are relevant to this review in Table 4.

We included four studies with 1397 participants that compared different types of HAs. These comparisons were between a short stem and standard stem (Lim 2020), a Thompson and a Exeter Trauma Stem (Parker 2012; Sims 2018), and an Austin-Moore and a Furlong (Livesley 1993). We briefly summarise the characteristics of these studies and the outcomes they report that are relevant to this review in Table 5.

We included 17 studies with 3232 participants that compared a THA with a HA (Baker 2006; Blomfeldt 2007; Cadossi 2013; Chammout 2019; Dorr 1986; HEALTH 2019; Iorio 2019; Keating 2006; Macaulay 2008; Mouzopoulos 2008; Parker 2019; Ravikumar 2000; Ren 2017; Sharma 2016; Sonaje 2017; Van den Bekerom 2010; Xu 2017). We briefly summarise the characteristics of these studies and the outcomes they report that are relevant to this review in Table 6.

We included three studies with 244 participants that compared different types of THAs. These comparisons were between a single articulation and a dual-mobility articulation (Griffin 2016; Rashed 2020), and a short stem and standard stem (Kim 2012). We briefly summarise the characteristics of these studies and the outcomes they report that are relevant to this review in Table 7.

We found no studies of large-head THAs compared with other arthroplasties.

Types of outcome measures

All studies in our main comparison groups reported data for at least one of our critical review outcomes.

Sources of funding and declarations of interest

Fourteen studies reported that they received no commercial or external funding (Baker 2006; Cadossi 2013; Calder 1996; Davison 2001; Emery 1991; Inngul 2015; Livesley 1993; Parker 2010c; Parker 2012; Parker 2019; Parker 2020; Santini 2005; Sonaje 2017; Van den Bekerom 2010), and six studies reported funding from independent sources such as research foundations (Chammout 2019; Fernandez 2022; Griffin 2016; HEALTH 2019; Keating 2006; Macaulay 2008). Eleven studies received support from manufacturers or insurance companies (Blomfeldt 2007; DeAngelis 2012; Dorr 1986; Figved 2009; Figved 2018; Hedbeck 2011; Raia 2003; Ravikumar 2000; Sims 2018; Talsnes 2013; Taylor 2012). Eight studies declared that the study investigators had no conflicts of interest (Cao 2017; Chammout 2017; Iorio 2019; Lim 2020; Movrin 2020; Rashed 2020; Vidovic 2013; Xu 2017). 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 not eligible for inclusion in this review, or were not treating participants with the type of fractures 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 eight key excluded studies (see Characteristics of excluded studies). We excluded five studies because they were abstracts with insufficient detail on the numbers of participants in each group, meaning extraction of outcome data was not feasible (Karpman 1992; Kavcic 2006; Rosen 1992; Stock 1997; Van Thiel 1988). We excluded one study that appeared to be randomised, but on closer inspection, we believed was not randomised (Somashekar 2013). We excluded one study that investigated the surgical approach rather than the type of intervention (Aydin 2009). We excluded one study from our clinical trials register search which was abandoned because of lack of funding, and its results are not reported (ISRCTN42349821).

Studies awaiting classification

We found four studies from the search of clinical trials 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). See Characteristics of studies awaiting classification.

Ongoing studies

We found seven ongoing studies (ChiCTR1800019531; ISRCTN15606075; NCT01109862; NCT01578408; NCT01787929; UMIN000011303; Wolf 2020). These studies have an estimated enrolment of 7199 participants, and evaluate the following comparison groups: 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 2020), and single versus dual antibiotic cement HA (ISRCTN15606075). See Characteristics of ongoing studies.

Risk of bias in included studies

We conducted risk of bias according to outcomes relevant to this review. Blank spaces in the risk of bias figure for some detection bias domains indicate that risk of bias assessment was not applicable as the outcome category was not reported. See Figure 2.

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study. Blank spaces indicate that risk of bias was not conducted because study authors did not report outcomes relevant to these domains.

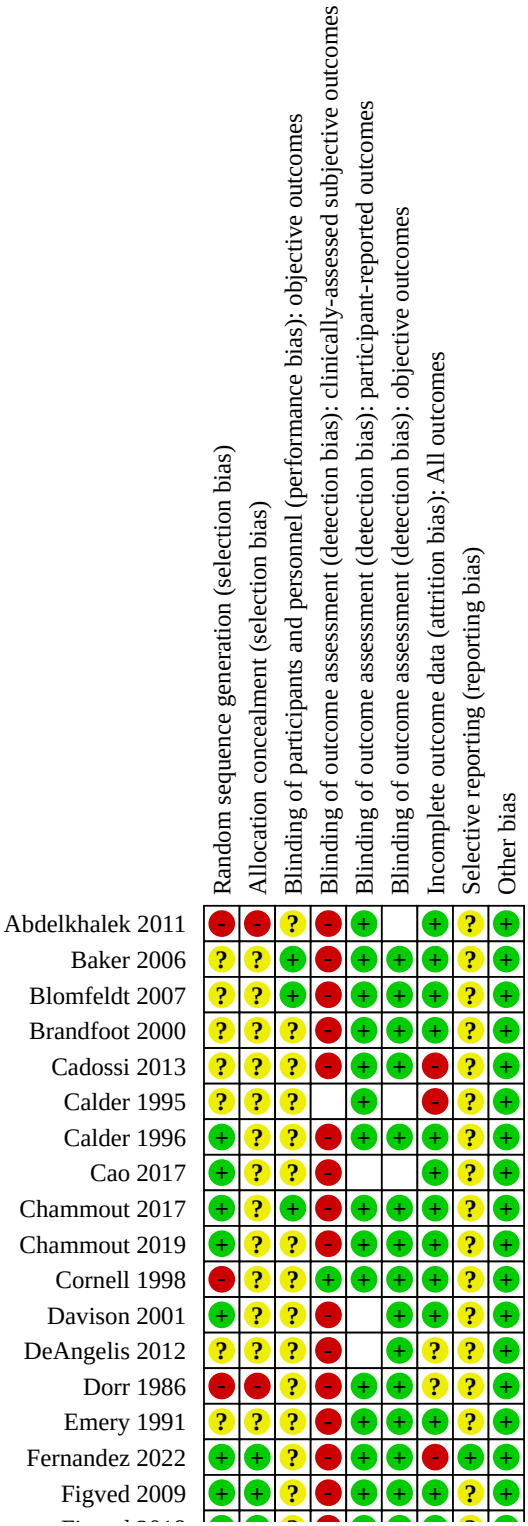
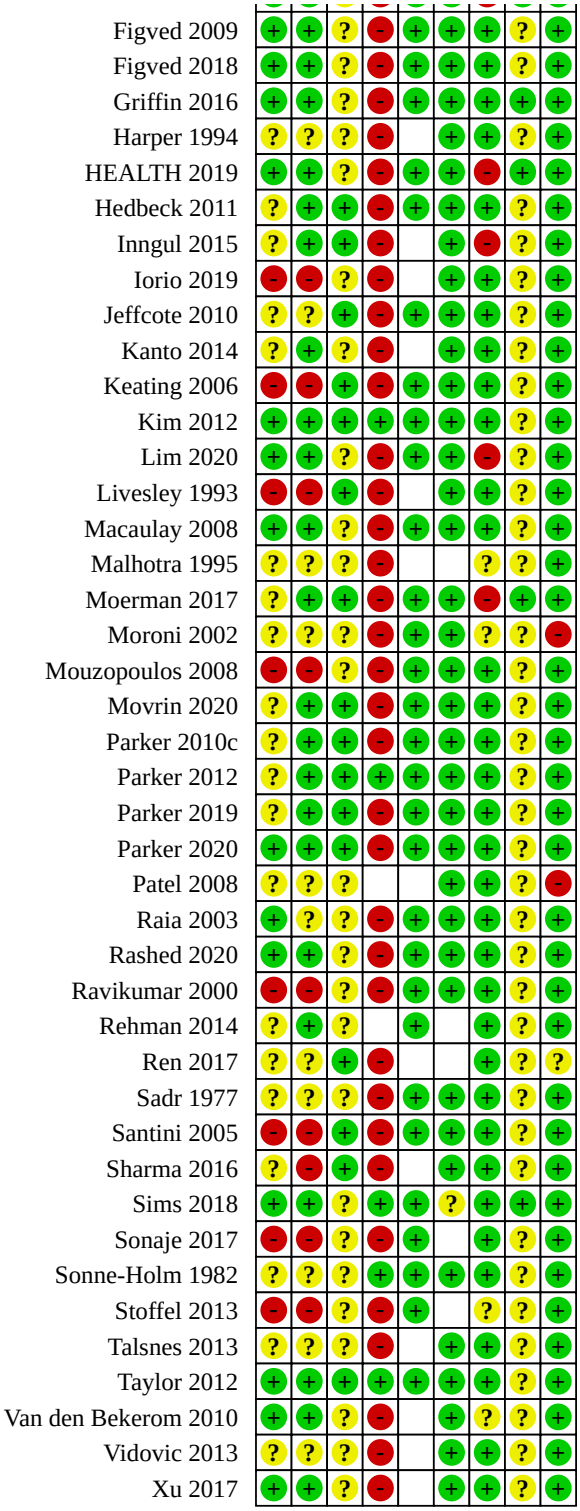


Figure 2. (Continued)



Allocation

Twenty studies reported an adequate method to randomise participants to groups, and we judged these studies be at low risk of selection bias for random sequence generation (Calder 1996; Cao 2017; Chammout 2017; Chammout 2019; Davison 2001; Fernandez 2022; Figved 2009; Figved 2018; Griffin 2016; HEALTH

2019; Kim 2012; Lim 2020; Macaulay 2008; Parker 2020; Raia 2003; Rashed 2020; Sims 2018; Taylor 2012; Van den Bekerom 2010; Xu 2017). We judged 11 studies to be at high risk of selection bias for random sequence generation because study authors used quasi-randomised methods to randomise participants to intervention groups or because other information within the study report indicated that selection bias may have been present (Abdelkhalek 2011; Cornell 1998; Dorr 1986; Iorio 2019; Keating 2006; Livesley 1993; Mouzopoulos 2008; Ravikumar 2000; Santini 2005; Sonaje 2017; Stoffel 2013). The remaining studies reported insufficient information and we judged risk of selection bias for random sequence generation to be unclear.

We judged 11 studies to be at high risk of bias for allocation concealment (Abdelkhalek 2011; Dorr 1986; Iorio 2019; Keating 2006; Livesley 1993; Mouzopoulos 2008; Ravikumar 2000; Santini 2005; Sharma 2016; Sonaje 2017; Stoffel 2013). Twenty-four studies reported insufficient information and we judged risk of selection bias for allocation to be unclear (Baker 2006; Blomfeldt 2007; Brandfoot 2000; Cadossi 2013; Calder 1995; Calder 1996; Cao 2017; Chammout 2017; Chammout 2019; Cornell 1998; Davison 2001; DeAngelis 2012; Emery 1991; Harper 1994; Jeffcote 2010; Malhotra 1995; Moroni 2002; Patel 2008; Raia 2003; Ren 2017; Sadr 1977; Sonne-Holm 1982; Talsnes 2013; Vidovic 2013). The remaining studies reported sufficient information, and we judged these to be at low risk of selection bias.

Blinding

It is not possible to blind the operating surgeon to the type of arthroplasty or the implant fixation methods used in these studies. In making judgements about performance bias, we considered whether surgeons were equally experienced with the types of implants used in their study. We judged only 19 studies to report this sufficiently well and we assessed these studies to be at low risk of performance bias (Baker 2006; Blomfeldt 2007; Chammout 2017; Hedbeck 2011; Inngul 2015; Jeffcote 2010; Keating 2006; Kim 2012; Livesley 1993; Moerman 2017; Movrin 2020; Parker 2010c; Parker 2012; Parker 2019; Parker 2020; Ren 2017; Santini 2005; Sharma 2016; Taylor 2012). We expected that all surgeons would aim for the same standard of performance when carrying out all surgical procedures. However, unless otherwise stated, we could not be certain in the remaining studies that surgeons were equally experienced with the prostheses and we judged risk of performance bias in these studies to be unclear.

For detection bias, we considered the type of outcome and who was measuring it. We found that most studies did not report who measured clinically-assessed outcomes that may be influenced by subjective decisions (such as performance in ADL, hip function or unplanned return to theatre). In these cases, we assumed that these judgements were made by surgeons who were aware of the intervention, which could influence their decision-making. Thus, we judged detection bias for these clinically-assessed subjective outcomes to be at high risk of bias. Only six studies reported that assessment of these outcomes was made by personnel who were unaware of treatment, and we judged these six studies to be at low risk of bias for these outcomes (Cornell 1998; Kim 2012; Parker 2012; Sims 2018; Sonne-Holm 1982; Taylor 2012). Although some participants may have been aware of the type of intervention used during their surgery, we did not expect that knowledge of this would influence how they reported information that contributed towards outcome data such as mobility, pain, and HRQoL. We therefore judged risk of detection bias for all participant-reported outcomes to be at low risk. We also judged detection bias to be at low risk for objective outcomes (such as mortality and length of stay), and we therefore judged all studies reporting these outcomes to be at low risk of detection bias.

Incomplete outcome data

Because of the high mortality in study population, we expected a large and unavoidable loss of outcome data from participants for outcomes measured with a longer follow-up. We judged most studies to be at low risk of attrition bias because other losses were few, were well-explained by study authors, and were balanced between groups. We judged only seven studies to be at high risk of attrition bias (Cadossi 2013; Calder 1995; Fernandez 2022; HEALTH 2019; Inngul 2015; Lim 2020; Moerman 2017). In these seven studies, we noted a large number of losses for outcomes reported at the end of follow-up (such as HRQoL or functional status) that could not be explained by death. In four studies, we could not be certain if data were complete, particularly for outcomes reported at the end of study follow-up (DeAngelis 2012; Dorr 1986; Malhotra 1995; Moroni 2002), and in two studies we could not be certain if the number of losses were balanced between intervention groups because of limited information in the study report (Stoffel 2013; Van den Bekerom 2010). We judged risk of attrition bias in these six studies to be unclear.

Selective reporting

Most studies did not report whether they were registered with a clinical trials register and did not provide details of protocols published prior to the study. Nine studies were registered retrospectively with a clinical trials register (Chammout 2017; Chammout 2019; DeAngelis 2012; Figved 2009; Figved 2018; Inngul 2015; Kanto 2014; Parker 2019; Parker 2020). Two reported registration with a clinical trials register, but because they did not report registration numbers, we were unable to source the trials register documents (Talsnes 2013; Taylor 2012). It is not feasible to effectively assess risk of selective reporting bias without these documents, and we judged risk of bias in all of these studies to be unclear.

Only five studies reported prospective clinical trials registration, with outcomes listed in these documents which were consistent with those measured and reported in the study report (Fernandez 2022; Griffin 2016; HEALTH 2019; Moerman 2017; Sims 2018). We judged these four studies to be at low risk of selective reporting bias.

Other potential sources of bias

Two studies were reported as abstracts, with limited study details, and we judged these to be at high risk of other bias because the reports were not peer-reviewed (Moroni 2002; Patel 2008). We judged other bias to be unclear in another study in which the study methods had limited detail and we could not be certain of bias (Ren 2017). We identified no other sources of bias in the remaining studies.

Effects of interventions

See: **Summary of findings 1** Cemented versus uncemented hemiarthroplasty for hip fracture in adults; **Summary of findings 2** Bipolar hemiarthroplasty compared with unipolar hemiarthroplasty for hip fracture in adults; **Summary of findings**

3 Total hip arthroplasty compared with hemiarthroplasty for hip fracture in adults

We report data available at three possible time points: early (within four months of surgery), 12 months (after four months and up to 24 months after surgery, prioritising data at 12 months if possible), and late (more than 24 months after surgery, at the latest time point reported by study authors). In the following, we report subgroup and sensitivity analyses only for comparisons for which they were appropriate and possible.

1. Prostheses implanted with cement versus without cement

Here we present three comparisons of cemented and uncemented prostheses - stratified by the categories THA, HA, and a mixed intervention of THA and HA (participants were treated with either a THA or HA which is cemented, or a THA or HA which is uncemented). A summary of the implant and study characteristics is presented in Table 3. For outcomes measured with scales, we present range of scores and direction of effect for each scale in Appendix 3.

THA: cemented versus uncemented

This comparison includes data from only one study with 69 participants (Chammout 2017).

Here we report the effects for critical outcomes, and we summarise the effects of other important outcomes in Table 8. All outcomes in this comparison are reported without GRADE assessments.

Critical outcomes

Activities of daily living (ADL)

Chammout 2017 provided scores for the ability to perform ADL but did not report the measurement tool used to score this data. We found no evidence of a difference in performing ADL at 3 months (mean difference (MD) 0.00, 95% confidence interval (CI) -0.17 to 0.17; 1 study, 65 participants; Analysis 1.1) and at 12 months after surgery (MD 0.10, 95% CI -0.22 to 0.42, favours uncemented; 1 study, 63 participants; Analysis 1.1).

Delirium

Chammout 2017 did not report this outcome.

Functional status

Chammout 2017 reported functional status measured with the Harris Hip Score (HHS), with higher scores indicating better function. We found no evidence of a difference in function at 3 months after surgery (MD 1.00, 95% CI -5.37 to 7.37, favours cemented; 1 study, 65 participants; Analysis 1.2) and at 12 months after surgery (MD -3.00, 95% CI -11.29 to 5.29, favours uncemented; 1 study, 65 participants; Analysis 1.2).

Health-related quality of life (HRQoL)

Chammout 2017 also reported HRQoL, measured using the EQ-5D (range of scores from 0 to 1; higher scores indicate better quality of life). We found no evidence of a difference in HRQoL at 3 months after surgery (MD 0.00, 95% CI -0.12 to 0.12; 1 study, 64 participants; Analysis 1.3) and at 12 months after surgery (MD 0.00, 95% CI -0.13 to 0.13; 1 study, 62 participants; Analysis 1.3).

Mobility

Chammout 2017 did not report this outcome.

Mortality

We found no evidence of a difference in mortality at 12 months (risk ratio (RR) 0.49, 95% CI 0.05 to 5.11, favours cemented; 1 study, 69 participants; Analysis 1.4).

Unplanned return to theatre

We found no evidence of a difference in return to theatre at 24 months (RR 0.11, 95% CI 0.01 to 1.93, favours cemented; 1 study, 69 participants; Analysis 1.5). Some re-operations were because of dislocation, subsidence or pain. We noted that types of re-operation included revision to HA and to change the liner to an elevated rim.

Other important outcomes

Effect estimates were imprecise; we found no evidence of a difference in pain or adverse events (intra- or postoperative periprosthetic fracture, loosening, superficial infection, and dislocation). We report the summary effects of important outcomes and adverse effects in Table 8.

HA: cemented versus uncemented

This comparison includes data from 17 studies with 3644 participants (Brandfoot 2000; Cao 2017; DeAngelis 2012; Emery 1991; Fernandez 2022; Figved 2009; Harper 1994; Moerman 2017; Movrin 2020; Parker 2010c; Rehman 2014; Sadr 1977; Santini 2005; Sonne-Holm 1982; Talsnes 2013; Taylor 2012; Vidovic 2013). We analysed the data from Cao 2017 separately because this study includes only participants with extracapsular fractures.

Here we report effects for critical outcomes. Where pooled analyses included at least one study in each category, we subgrouped the analysis according to whether studies used a modern or a first-generation, uncemented stem design in one of the intervention groups. Of the 16 studies including participants with intracapsular fractures, eight reported a comparison between cemented and modern uncemented HAs.

We used GRADE to assess the certainty of the evidence for the critical outcomes measured within four months of surgery (ADL, functional status, HRQoL, and mobility), within four months and at 12 months for mortality, and at the end of follow-up for delirium and unplanned return to theatre. See Summary of findings 1.

We summarise the effects of other important review outcomes in a table, which are not subgrouped according to the stem design; these outcomes are reported without GRADE assessments.

Critical outcomes

ADL

Seven studies reported performance of ADL. The uncemented stem designs in these studies were modern (DeAngelis 2012; Fernandez 2022; Figved 2009; Moerman 2017; Parker 2020), first generation (Brandfoot 2000), or the type of stem was unknown (Santini 2005).

Early:

- Moerman 2017 used the Groningen Activity Restriction Scale (GARS) at four months, and Parker 2020 used a social dependency scale at four months. For both instruments, lower scores indicate more independence. DeAngelis 2012 used the Older Americans Resources Scale of Instrumental Activities

of Daily Living (OARS-IADL), and Fernandez 2022 used a five-point Likert scale for 'usual activities' derived from the EQ-5D utility index; we inverted the data in these studies to account for these instruments in which higher scores indicate more independence. We found no evidence of a difference in performance of ADL (SMD -0.03, 95% CI -0.21 to 0.16, favours cemented; 4 studies, 1275 participants; I^2 = 53%; moderate-certainty evidence; Analysis 2.1). We downgraded the certainty of the evidence by one level for study limitations because studies had unclear risks of bias.

- In addition, Figved 2009 reported the number of people who were independent at three months, defined as those scoring 19 or 20 on the Barthel Index Score. From these data, we found no evidence of a difference in performance of ADL (RR 0.88, 95% CI 0.65 to 1.19, favours uncemented; 1 study, 190 participants; Analysis 2.2).

At 12 months:

- Moerman 2017 used the GARS and Parker 2020 used a social dependency scale. Santini 2005 used the Verona Elderly Care (VELCA) scoring system, DeAngelis 2012 used the OARS-IADL, and Fernandez 2022 used a five-point Likert scale; we inverted the data for these studies to account for those instruments in which higher scores indicate more independence. We found no evidence of a difference in performance of ADL (SMD -0.09, 95% CI -0.21 to 0.02, favours cemented; 5 studies, 1173 participants; I^2 = 0%; Analysis 2.3). Data in this analysis were reported at 12 months in all studies.
- Figved 2009 reported the number of people who were independent at 12 months, defined as those scoring 19 or 20 on the Barthel Score. From these data, we found no evidence of a difference in performance of ADL (RR 0.79, 95% CI 0.61 to 1.04, favours uncemented; 1 study, 168 participants; Analysis 2.4).
- In addition, Brandfoot 2000 reported ADL outcome at 16 months using a modification of the HHS, extracting responses from the instrument related to using stairs, socks, shoes, and bathing. We did not calculate an effect estimate because data were reported as a measure of the variance. See Appendix 4 for mean scores as reported by study authors.

Late:

- Figved 2009 reported the number of people who were independent at five years, defined as those scoring 19 or 20 on the Barthel Score. From these data, we found no evidence of a difference in performance of ADL (RR 0.87, 95% CI 0.63 to 1.21, favours uncemented; 1 study, 80 participants; Analysis 2.5).

Delirium

Two studies reported data for delirium. The uncemented stem designs in these studies were modern (Parker 2020), and first generation (Parker 2010c). We found no evidence of a difference for this outcome (RR 1.06, 95% CI 0.55 to 2.06, favours uncemented; 2 studies, 800 participants; I^2 = 0%; low-certainty evidence; Analysis 2.6). We downgraded the certainty of the evidence by two levels - one level for imprecision because we noted a wide CI in the estimate, and one level for study limitations because the studies had unclear risks of bias.

Functional status

Eight studies reported data for functional status. The uncemented stem designs in these studies were modern (Cao 2017; Figved 2009; Movrin 2020), first generation (Brandfoot 2000; Sadr 1977; Sonne-Holm 1982; Vidovic 2013), or unknown (Santini 2005).

Early:

- Three studies reported function using the HHS (Figved 2009; Movrin 2020; Vidovic 2013). For this instrument, higher scores indicate better function. We found improved function with cemented HAs (MD 3.38, 95% CI 0.05 to 6.70, favours cemented; 3 studies, 416 participants; very low-certainty; Analysis 2.7). We noted that this estimate did not indicate a clinically important improvement (based on a minimal clinically important difference (MCID)) of 16 to 18 points (Singh 2016). We downgraded the certainty of the evidence by one level for imprecision because the evidence included few studies, and two levels for study limitations because the studies had unclear risks of bias, and we found during sensitivity analysis that the effect estimate was influenced by these studies (see below).
- In addition, Sonne-Holm 1982 reported the number of participants with a maximum score on the D'Aubigne scale indicating good functional status (D'Aubigne 1954. From these data, we found no evidence of a difference in functional status (RR 1.15, 95% CI 0.84 to 1.59, favours cemented; 1 study, 75 participants; Analysis 2.8).
- Cao 2017 reported function using the HHS at three months, and we found improved function with cemented HAs for extracapsular fractures (MD 14.70, 95% CI 11.78 to 17.62, favours cemented; 1 study, 85 participants; Analysis 2.9). We noted that the CI in this estimate may indicate a clinically important improvement with cemented HAs based on a MCID of 16 to 18 points (Singh 2016).

At 12 months:

- Three studies reported this outcome using the HHS (Figved 2009; Movrin 2020; Vidovic 2013), Taylor 2012 used the Oxford Hip Score (OHS), and Santini 2005 used the VELCA scoring system. For all instruments, higher values indicate better function. The estimate was imprecise, including clinically relevant benefits in favour of cemented implants but also no difference between interventions (SMD 0.13, 95% CI -0.09 to 0.35, favours cemented; 5 studies, 494 participants; I^2 = 31%; Analysis 2.10). We pooled data reported at 12 months (Figved 2009; Santini 2005; Taylor 2012; Vidovic 2013), and at 24 months (Movrin 2020).
- Sadr 1977 reported data using the HHS measured at 17 months; scores were categorically reported as excellent, good, medium or poor. We combined the good and excellent scores with maximum scores from Sonne-Holm 1982, reported at 12 months. We found no evidence of a difference in functional status (RR 1.15, 95% CI 0.91 to 1.45, favours cemented; 2 studies, 100 participants; I^2 = 0%; Analysis 2.11).
- Cao 2017 reported function using the HHS at 6 months, and we found improved function with cemented HAs for extracapsular fractures (MD 11.09, 95% CI 7.70 to 14.48, favours cemented; 1 study, 85 participants; Analysis 2.12). We noted that the CI is unlikely to be compatible with a clinically important improvement (Singh 2016).

- In addition, Brandfoot 2000 reported this outcome at 16 months using the HHS. We did not pool data from this study in the analysis because the data were reported without any measures of variance. See Appendix 4 for mean scores as reported by study authors.

Late:

- Figved 2009 also reported functional status outcome at five years, but the estimate was imprecise (MD -9.90, 95% CI -17.75 to -2.05, favours uncemented; 1 study, 78 participants; Analysis 2.13).

HRQoL

Three studies reported HRQoL (Fernandez 2022; Figved 2009; Moerman 2017). These studies used modern, uncemented stem designs. We extracted data for the physical component of the Short-Form 12 (SF-12) for Moerman 2017, and EQ-5D for Fernandez 2022 and Figved 2009. In both scales, higher scores indicate better quality of life.

Early:

- We found improved HRQoL for cemented HAs (SMD 0.20, 95% CI 0.07 to 0.34, favours cemented; 3 studies, 1122 participants; I^2 = 9%; moderate-certainty evidence; Analysis 2.14). The outcome was measured at four months in Fernandez 2022 and at three months in the other studies. After converting this effect estimate onto the EQ-5D utility scale, the difference between fixation techniques was compatible with clinically small and large benefits of cemented HAs (0.06, 95% CI 0.02 to 0.10); this was based on a MCID for EQ-5D of 0.07 (Walters 2005). We downgraded the certainty of the evidence by one level for study limitations because the studies had high and unclear risks of bias.

At 12 months:

- We found improved HRQoL for cemented HAs (SMD 0.12, 95% CI 0.00 to 0.24, favours cemented; 3 studies, 1079 participants; I^2 = 0%; Analysis 2.15). After converting this effect estimate onto the EQ-5D utility scale, the difference was compatible with no effect or a clinically important benefit of cemented HAs (0.03, 95% CI 0.00 to 0.07); this was based on a MCID for EQ-5D of 0.07 (Walters 2005).

Late:

- Figved 2009 also reported HRQoL at five years, with no evidence of a difference between fixation techniques (MD -0.09, 95% CI -0.23 to 0.05, favours uncemented; 1 study, 71 participants; I^2 = 0%; Analysis 2.16).

Mobility

Eleven studies reported data for mobility. The uncemented stem designs in these studies were modern (Fernandez 2022; Figved 2009; Moerman 2017; Parker 2020; Taylor 2012), first generation (Brandfoot 2000; Emery 1991; Parker 2010c; Rehman 2014; Sonne-Holm 1982), and unknown (Santini 2005).

Early:

- Three studies reported the proportion of people who were able to walk independently at three months (Figved 2009; Sonne-Holm 1982), and four months (Fernandez 2022). We found no evidence of a difference in mobility (RR 1.04, 95% CI 0.95 to 1.14, favours cemented; 3 studies, 980 participants; I^2 = 5%; moderate-certainty evidence; Analysis 2.17). We downgraded the certainty of the evidence by one level for study limitations because included studies had unclear risks of bias.
- Parker 2010c and Parker 2020 used a nine-point mobility scale in which lower scores indicate better mobility, and Moerman 2017 used a nine-point mobility scale in which higher scores indicate better mobility. We inverted the data in Moerman 2017 before pooling. We found that mobility was improved with cemented prostheses (SMD -0.26, 95% CI -0.40 to -0.12, favours cemented; 3 studies, 766 participants; I^2 = 0%; Analysis 2.18). This effect size is likely to be small to medium (Cohen 1988).
- Rehman 2014 used a nine-point mobility rating scale, in which higher scores indicated better mobility; these data were reported as mean reduction values. We found that mobility was improved with uncemented HA (MD -0.40, 95% CI -0.68 to -0.12, favours uncemented; 1 study, 110 participants; Analysis 2.19). This effect estimate was imprecise, including clinically relevant benefits and harms (Cohen 1988).

At 12 months:

- Parker 2010c and Parker 2020 used a nine-point scale in which lower scores indicate better mobility. Moerman 2017 used a nine-point scale and Santini 2005 reported a six-point subscale for walking abilities from the VELCA scoring system; for both scales, higher scores indicate better mobility. We inverted the data in Moerman 2017 and Santini 2005 before pooling. We found that mobility was improved with a cemented HA (SMD -0.24, 95% CI -0.42 to -0.06, favours cemented; 4 studies, 762 participants; I^2 = 32%; Analysis 2.20). This effect size is likely to be small to medium (Cohen 1988).
- Three studies reported the proportion of people who were able to walk independently at 12 months (Fernandez 2022; Figved 2009; Sonne-Holm 1982). We found no evidence of a difference in mobility (RR 0.98, 95% CI 0.70 to 1.37, favours uncemented; 3 studies, 826 participants; I^2 = 84%; Analysis 2.21).
- Emery 1991 reported the number of people who were more dependent on walking aids at 17 months after surgery than before their injury. We found that mobility was better using a cemented HA (RR 0.53, 95% CI 0.30 to 0.93, favours cemented; 1 study, 39 participants; Analysis 2.22).
- In addition, Brandfoot 2000 reported this outcome at 16 months, using responses extracted from the HHS, and Taylor 2012 reported this using the Timed Up and Go (TUG) test at 24 months. We did not pool data from these studies in the analyses because the data were reported without variances. See Appendix 4 for mean scores, as reported by study authors.

Late:

- Parker 2010c reported data at five years, using a nine-point mobility scale in which lower scores indicate better mobility. We found no evidence of a difference in mobility (MD -0.60, 95% CI -1.79 to 0.59, favours cemented; 1 study, 64 participants; Analysis 2.23).

- Figved 2009 reported the number of people who were able to walk independently at five years. We found no evidence of a difference in mobility (RR 0.88, 95% CI 0.75 to 1.02, favours uncemented; 1 study, 79 participants; Analysis 2.24).

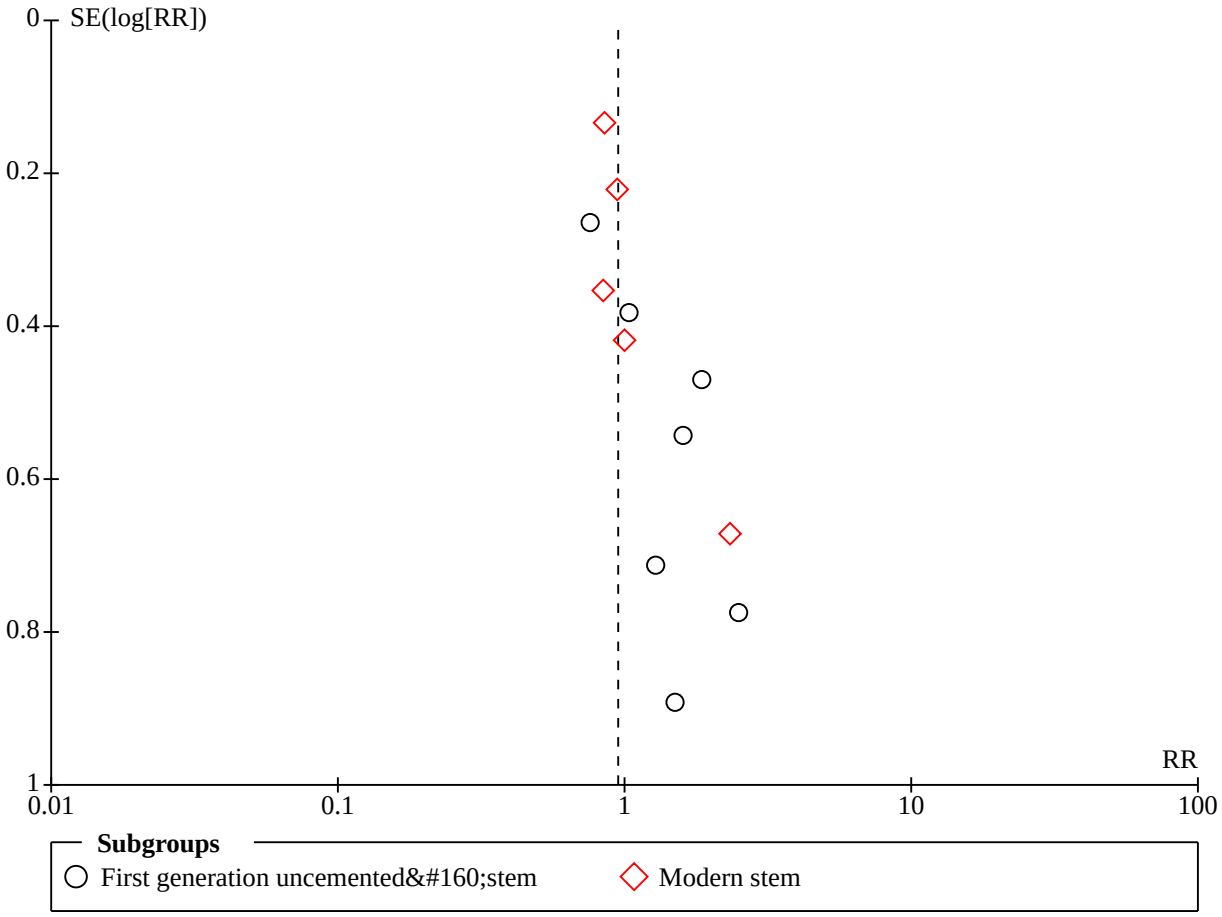
Mortality

Fifteen studies reported mortality. The uncemented stem designs in these studies were modern (Fernandez 2022; Figved 2009; Moerman 2017; Movrin 2020; Parker 2020; Talsnes 2013; Taylor 2012), first generation (Brandfoot 2000; Emery 1991; Harper 1994; Parker 2010c; Sadr 1977; Sonne-Holm 1982; Vidovic 2013), or unknown (Santini 2005).

Early:

- The estimate for mortality within four months of surgery includes clinically relevant harms and benefits (RR 0.95, 95% CI 0.80 to 1.13, favours cemented; 12 studies, 3136 participants; I^2 = 0%; low-certainty evidence; Analysis 2.25). We downgraded the certainty of the evidence by one level for imprecision because the CI included both possible harms and benefits, and one level for study limitations because most studies in this analysis had unclear or high risks of bias. We generated a funnel plot (Figure 3), and we found evidence of small study effects which tend to favour cemented HAs (Harbord modified test, P value = 0.003).

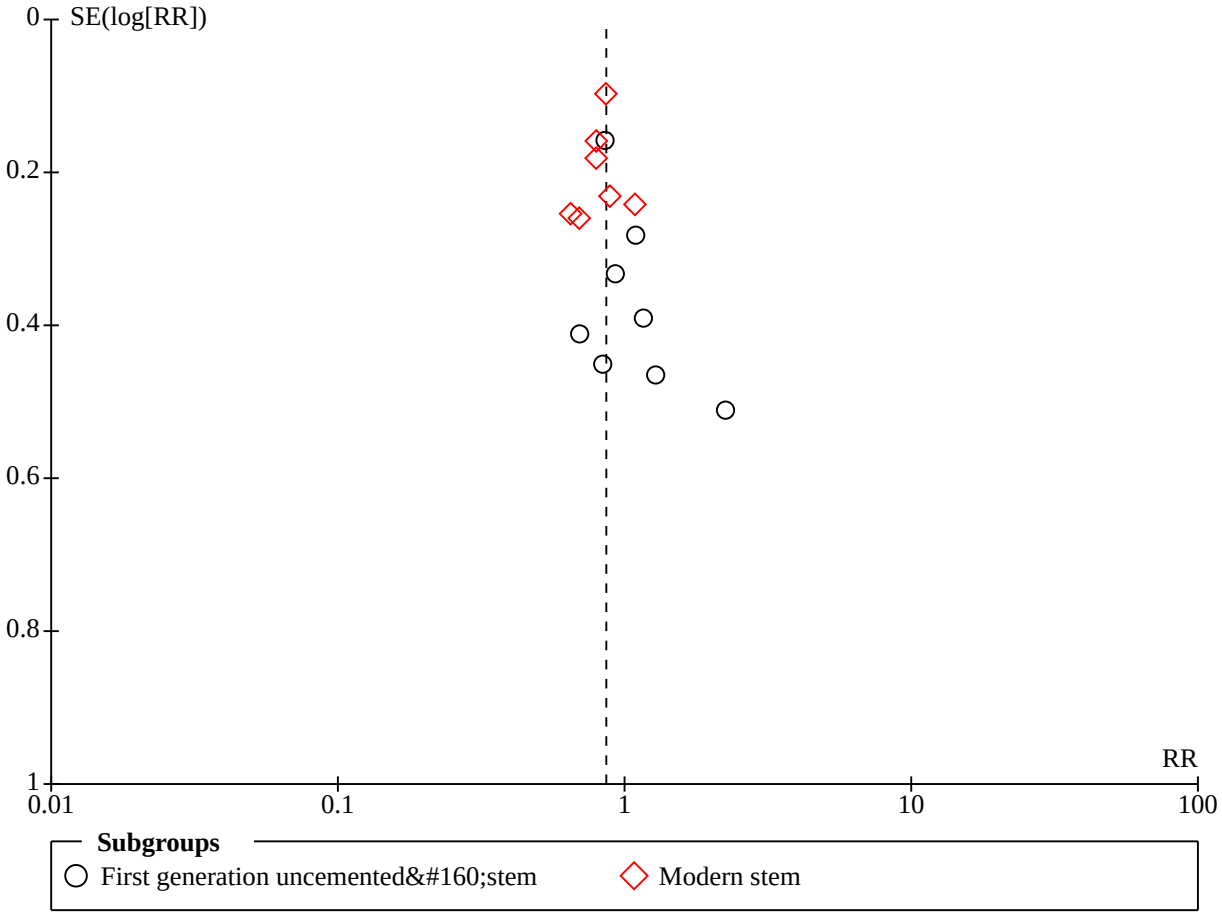
Figure 3. Cemented hemiarthroplasty versus uncemented hemiarthroplasty. Funnel plot for early mortality (≤ 4 months), subgrouped by stem design



At 12 months:

- We found that the risk of death at 12 months was reduced using cemented HA (RR 0.86, 95% CI 0.78 to 0.96, favours cemented; 15 studies, 3727 participants; I^2 = 0%; moderate-certainty evidence; Analysis 2.26). This analysis included data reported at 16 months (Brandfoot 2000), 18 months (Emery 1991), and 24 months (Movrin 2020). We downgraded the certainty of the evidence by one level for study limitations because most studies in this analyses had unclear or high risks of bias. We generated a funnel plot (Figure 4), and we found no statistical evidence of small study size effects (Harbord modified test, P value = 0.169).

Figure 4. Cemented hemiarthroplasty versus uncemented hemiarthroplasty. Funnel plot for mortality at 12 months, subgrouped by stem design



Late:

- Two studies reported data at a time point of five years (Figved 2009; Parker 2010c). We found no evidence of a difference in mortality according to the fixation technique (RR 1.01, 95% CI 0.89 to 1.25, favours uncemented; 2 studies, 620 participants; Analysis 2.27).

Unplanned return to theatre

Six studies reported unplanned return to theatre at the end of study follow-up, which was at 12 months (DeAngelis 2012; Fernandez 2022; Figved 2009; Moerman 2017), 24 months (Taylor 2012), and 60 months (Parker 2010c). The effect estimate was imprecise, including benefits and harms (RR 0.70, 95% CI 0.45 to 1.10, favours cemented; 6 studies, 2336 participants; I^2 = 0%; low-certainty evidence; Analysis 2.28). Some re-operations were because of dislocation, loosening, acetabular wear, periprosthetic fracture or infection. We noted that types of re-operation included replacement with THA, Girdlestone and open reduction and drainage of infection. We downgraded the certainty of the evidence by two levels for study limitations because most studies in the analysis had unclear risks of bias and all studies were at high risk of detection bias.

Other important outcomes

It was difficult to interpret pain outcomes because studies reported this outcome using different instruments and scales. We found no evidence of a difference in the number of people who were discharged to their own home according to the fixation technique. Similarly, we found no evidence of a difference in most adverse events unrelated to the implant or fracture, or both, according to whether or not cement was used to fix the HA (acute kidney injury, cerebrovascular accident, chest infection/pneumonia, myocardial infarction, urinary tract infection, deep vein thrombosis, and pulmonary infection). However, we noted that fewer people had a pulmonary embolism when the HA was fixed without cement. Cao 2017 reported no adverse events in either group of participants with extracapsular fractures (intraoperative fractures, loosening, deep infection, superficial infection, and dislocation). We report the summary effects of all these important outcomes and adverse effects in Table 9.

Subgroup analysis

We did not conduct subgroup analysis to explore differences between studies according to our pre-specified effect modifiers (age, gender, and fracture displacement) because these variables were insufficiently reported.

Visual inspection of the forest plots for each outcome where data were available in both first generation and modern uncemented HA subgroups showed that the overall trend for benefits associated with cemented HA were reduced in the modern uncemented subgroup. However, these subgroups were sparse and few studies were available across most of the comparisons. We conducted a formal subgroup analysis for mortality at 12 months because this analysis had sufficient studies. Santini 2005 did not report the exact type of uncemented HA, and we chose to include this study in the first generation subgroup. On visual inspection of the data, we noted that the reduction in mortality was increased amongst studies reporting a comparison with a modern uncemented design of HA rather than a first generation uncemented design (RR 0.80, 95% CI 0.68 to 0.95; 6 studies, 1466 participants, favours cemented modern HA; I^2 = 0%; Analysis 2.26; Figure 4). However, this was not supported by formal tests of interaction (P = 0.24).

Sensitivity analysis

Here, we report the results of sensitivity analyses only when we noted a difference in interpretation of the effect.

High or unclear risk of selection bias (for sequence generation)

- Early functional status (≤ four months; continuous data): we excluded two studies from this analysis (Movrin 2020; Vidovic 2013). Although the effect continued to show no evidence of a difference between groups, we noted that the estimate favoured the alternative intervention (MD -1.20, 95% CI -6.66 to 4.26, favours uncemented; 1 study, 189 participants).
- Functional status (at 12 months; continuous data): we excluded three studies from this analysis (Movrin 2020; Santini 2005; Vidovic 2013). Although the effect continued to show no evidence of a difference between groups, we noted that the estimate favoured the alternative intervention (MD -0.02, 95% CI -0.28 to 0.24, favours uncemented; 2 studies, 234 participants).
- Early mobility (reported at ≤ four months; continuous data): we excluded two studies from this analysis (Moerman 2017; Parker 2010c). We found that the analysis no longer showed an improvement in mobility when the prosthesis was cemented (MD -0.40, 95% CI -0.81 to 0.01; 1 study, 329 participants).

High risk of attrition bias

In this sensitivity analysis, we considered attrition bias at the outcome level. We therefore conducted sensitivity analysis only on outcomes that included a study with high risk of attrition bias owing to losses for that specific outcome. We found no difference in the interpretation of the effect for all outcomes in this comparison.

Mixed HA and THA: cemented versus uncemented

This comparison includes data from two studies with 169 participants (Inngul 2015; Moroni 2002). In both studies, participants were randomised to a cemented or uncemented prosthesis, but the selection of a THA or HA was left to the treating surgeon and participant to select.

Here we report the effects for critical outcomes, and we summarise the effects of other important review outcomes in a table. These outcomes are reported without GRADE assessments.

Critical outcomes

ADL, delirium, and mobility

Neither study reported data for these outcomes.

Functional status

Both studies reported functional status measured using the HHS, with higher scores indicating better function.

At 12 months:

- We calculated an effect estimate for Moroni 2002 but this estimate was very imprecise. We found no evidence of a difference in functional status at 24 months from surgery (MD -16.00, 95% CI -41.57 to 9.57, favours uncemented; 1 study, 28 participants; Analysis 3.1).

Inngul 2015 also reported data for this outcome at 4 months, 12 months and 4 years using the HHS, but we could not calculate effect estimates because the study authors did not clearly report the number of participants available in each group. See Appendix 4 for mean scores as reported by study authors.

HRQoL

Only Moroni 2002 reported this outcome, measured using SF-36 at 24 months. This estimate was very imprecise. We found no evidence of a difference in HRQoL (MD -19.00, 95% CI -42.77 to 4.77, favours uncemented; 1 study, 28 participants; Analysis 3.2).

Mortality

Both studies reported mortality (Inngul 2015; Moroni 2002).

Early:

- The effect estimate for mortality at four months was very imprecise, including clinically relevant harms and benefits (RR 4.42, 95% CI 0.51 to 38.55, favours uncemented; 1 study, 141 participants; Analysis 3.3).

At 12 months:

- Similarly, the estimate for mortality at 12 months was imprecise (RR 2.02, 95% CI 0.81 to 5.07, favours uncemented; 2 studies, 169 participants; I^2 = 0%; Analysis 3.4). Moroni 2002 did not report mortality at 12 months, and this analysis includes data at 24 months from this study.

Late:

- Data were available at four years in Inngul 2015, and the estimate was also imprecise (RR 0.88, 95% CI 0.50 to 1.56, favours cemented; 1 study, 141 participants; Analysis 3.5).

Unplanned return to theatre

Only Inngul 2015 reported unplanned return to theatre. The estimate was imprecise, showing no evidence of a difference at four years after surgery (RR 0.74, 95% CI 0.22 to 2.50, favours uncemented; 1 study, 141 participants; Analysis 3.8). Indications for re-operation were dislocation and periprosthetic fracture, and revision included THA.

Other important outcomes

We found no evidence of a difference in some adverse events related to the implant or fracture, or both (superficial infection and dislocation). However, we noted fewer intraoperative periprosthetic fractures when cement was used in Inngul 2015 (0.06, 95% CI 0.00 to 0.98; 1 study, 141 participants; Analysis 3.9). We found no evidence of a difference in adverse events unrelated to the implant or fracture, or both (acute kidney injury, pneumonia, myocardial infarction, urinary tract infection). We report the summary effects for these adverse events in Table 10.

2. Bipolar HA versus unipolar HA

This comparison includes 13 studies with 1499 participants (Abdelkhalek 2011; Calder 1995; Calder 1996; Cornell 1998; Davison 2001; Figved 2018; Hedbeck 2011; Jeffcote 2010; Kanto 2014; Malhotra 1995; Patel 2008; Raia 2003; Stoffel 2013). A summary of the types of implants and study characteristics is presented in Table 4. Whilst cemented prostheses were reported in most studies in this comparison, three studies reported outcomes with uncemented prostheses (Figved 2018; Malhotra 1995; Patel 2008), and in one study, mixed cemented and uncemented prostheses were included in both groups (Abdelkhalek 2011).

Here we report effects for critical outcomes. Where analyses included at least one study in each category, we subgrouped the analysis according to whether studies reported interventions with cemented or uncemented prostheses.

We used GRADE to assess the certainty of the evidence for the critical outcomes measured within four months of surgery (ADL, functional status, HRQoL, and mobility), within 4 months and at 12 months for mortality, and at the end of follow-up for delirium and unplanned return to theatre. See Summary of findings 2.

We summarise the effects of other important review outcomes in a table, which are not subgrouped by stem fixation. These outcomes are reported without GRADE assessments.

For outcomes measured with scales, we present range of scores and direction of effect for each scale in Appendix 3.

Critical outcomes

ADL

Two studies reported performance of ADL; in both studies, the prostheses were cemented (Hedbeck 2011; Raia 2003).

At 12 months:

- Hedbeck 2011 used the Katz Index to identify participants who were independent (Katz 1963). We found no evidence of a difference in the number of people who were independent in ADL at 12 months (RR 1.06, 95% CI 0.85 to 1.33, favours bipolar; 1 study, 99 participants; Analysis 4.1).
- In addition, Raia 2003 reported this outcome at 12 months using the ADL subset score of the Musculoskeletal Functional Assessment Instrument. We did not calculate an effect estimate because data were reported without distribution variables. See Appendix 5 for average scores as reported by study authors.

Delirium

Stoffel 2013 reported delirium following cemented HAs. We found no evidence of a difference in postoperative delirium (RR 0.48, 95% CI 0.09 to 2.58, favours bipolar; 1 study, 261 participants; very low-certainty evidence; Analysis 4.2). We downgraded the certainty of the evidence by three levels - two levels for imprecision because the evidence included very few participants, and one level for study limitations because the included study had high and unclear risks of bias.

Functional status

Eight studies reported functional status. Studies included cemented (Cornell 1998; Davison 2001; Hedbeck 2011; Raia 2003; Stoffel 2013), uncemented (Figved 2018; Malhotra 1995), and a mixture of cemented and uncemented HAs in both the bipolar and unipolar groups (Abdelkhalek 2011).

Early:

- Hedbeck 2011 reported this outcome using the HHS at four months. We did not calculate an effect estimate for this study because data were reported without measures of variance. See Appendix 5 for mean scores as reported by study authors.

At 12 months:

- Two studies reported this outcome, using the HHS (Stoffel 2013), and the Johansen hip score (Cornell 1998). In both scales, higher scores indicate better function. This analysis included data at 12 months (Stoffel 2013), and at 6 months (Cornell 1998). This estimate was imprecise, including clinically relevant benefits and harms; we found no evidence of a difference according to the articulation of the HA (SMD -0.04, 95% CI -0.27 to 0.19, favours unipolar; 2 studies, 299 participants; I^2 = 0%; Analysis 4.3).
- Malhotra 1995 reported categorical data using the Devas 1983 system. Ranges of scores were reported as excellent, good, medium, or poor, and we combined data for scores which were excellent and good. We found no evidence of a difference according to the articulation of the HA (RR 1.17, 95% CI 0.95 to 1.43, favours bipolar; 1 study, 68 participants; Analysis 4.4).
- In addition, four studies reported this outcome using the HHS at 12 months (Davison 2001; Figved 2018; Hedbeck 2011), and physical function scores of SF-36 (Raia 2003). We did not calculate effect estimates for these studies because data were reported without means or without an appropriate measure of variance. See Appendix 5 for data as reported by study authors.

Late:

- One study reported categorical data using the HHS (Abdelkhalek 2011). Ranges of scores were reported as excellent, good, medium, or poor, and we combined data for scores which were excellent and good. We found no evidence of a difference according to the articulation of the HA (RR 1.28, 95% CI 0.98 to 1.67, favours bipolar; 1 study, 50 participants; Analysis 4.5).
- In addition, one study reported this outcome using the HHS at five years (Davison 2001). We did not calculate an effect estimate for this study because data were reported without an appropriate measure of variance. See Appendix 5 for mean scores as reported by study authors.

HRQoL

Three studies reported HRQoL. These studies included cemented (Hedbeck 2011; Raia 2003), and uncemented HAs (Figved 2018).

Early:

- Hedbeck 2011 reported data using EQ-5D up to four months since surgery; in this scale, higher scores indicate better quality of life. We found no evidence of a difference in HRQoL according to the articulation of the HA (MD 0.08, 95% CI -0.03 to 0.19, favours bipolar; 1 study, 115 participants; very low-certainty evidence; Analysis 4.6). We downgraded the certainty of the evidence by three levels - two levels for imprecision because data were available from only one small study, and one level for study limitations because this study had unclear risks of bias.

At 12 months:

- One study reported data using EQ-5D at 12 months (Hedbeck 2011). We found no evidence of a difference in quality of life at 12 months (MD 0.03, 95% CI -0.08 to 0.14, favours bipolar; 1 study, 99 participants; very low-certainty evidence; Analysis 4.7).
- In addition, Figved 2018 reported this outcome using EQ-5D, and Raia 2003 reported this outcome at 12 months using SF-36. We did not pool data from these studies because data were reported without an appropriate measure of variance. See Appendix 5 for average scores as reported by study authors.

Mobility

Five studies reported data for mobility within 12 months, and the HAs in all these studies were fixed with cement (Calder 1995; Calder 1996; Cornell 1998; Raia 2003; Stoffel 2013).

- Cornell 1998 used TUG at six months, and we found no evidence of a difference in mobility according to articulation of the HA (MD 5.80, 95% CI -6.83 to 18.43, favours unipolar; 1 study, 48 participants; Analysis 4.8).
- Stoffel 2013 used a six-minute walk test at 12 months. We found the mobility was better when a unipolar HA was used (MD -45.00 metres, 95% CI -80.64 to -9.36, favours unipolar; 1 study, 186 participants; Analysis 4.9). The CI in this effect may suggest a clinically important improvement in mobility when a unipolar HA was used (based on a MCID of 59.4 metres in Overgaard 2017).
- In addition, we did not calculate an effect estimate for three studies because these data were reported without distribution variables (Calder 1995; Calder 1996; Raia 2003). In Calder 1995 and Calder 1996, study authors reported mobility scores using a subscale of the Nottingham Health Profile. Raia 2003 reported average mobility scores using the Musculoskeletal Functional Assessment Instrument. See Appendix 5 for average scores as reported by study authors.

Mortality

Nine studies reported mortality. Studies included cemented (Calder 1996; Cornell 1998; Davison 2001; Hedbeck 2011; Jeffcote 2010; Kanto 2014; Raia 2003), and uncemented HAs (Figved 2018; Patel 2008).

Early:

- The estimate for mortality within four months of surgery was very imprecise, including clinically relevant benefits and harms (RR 0.94, 95% CI 0.54 to 1.64, favours bipolar; 4 studies, 573 participants; I^2 = 3%; low-certainty evidence; Analysis 4.10). We downgraded the certainty of the evidence by one level for imprecision because we noted a wide CI in the effect estimate, and one level because some of the included studies had unclear risks of bias.

At 12 months:

- Similarly, the estimate for mortality at 12 months from surgery was very imprecise, including clinically relevant benefits and harms (RR 1.17, 95% CI 0.89 to 1.53, favours unipolar; 8 studies, 839 participants; I^2 = 0%; low-certainty evidence; Analysis 4.11). This analysis included data reported at 6 months (Cornell 1998), 13 months (Patel 2008), and 24 months (Jeffcote 2010). We downgraded the certainty of the evidence by one level for imprecision because we noted a wide CI in the effect estimate, and one level because some of the included studies had unclear risks of bias.

Late:

- Two studies also reported mortality after 24 months from surgery, at 36 months (Davison 2001), and 60 months (Kanto 2014). We found no evidence of a difference in mortality at this late time point according to the articulation of the HA (RR 0.94, 95% CI 0.72 to 1.23, favours bipolar; 2 studies, 362 participants; I^2 = 0%; Analysis 4.12).

Unplanned return to theatre

Four studies reported unplanned return to theatre. Studies included cemented (Davison 2001; Hedbeck 2011; Kanto 2014), and a mixture of cemented and uncemented stems in both the bipolar and unipolar groups (Abdelkhalek 2011).

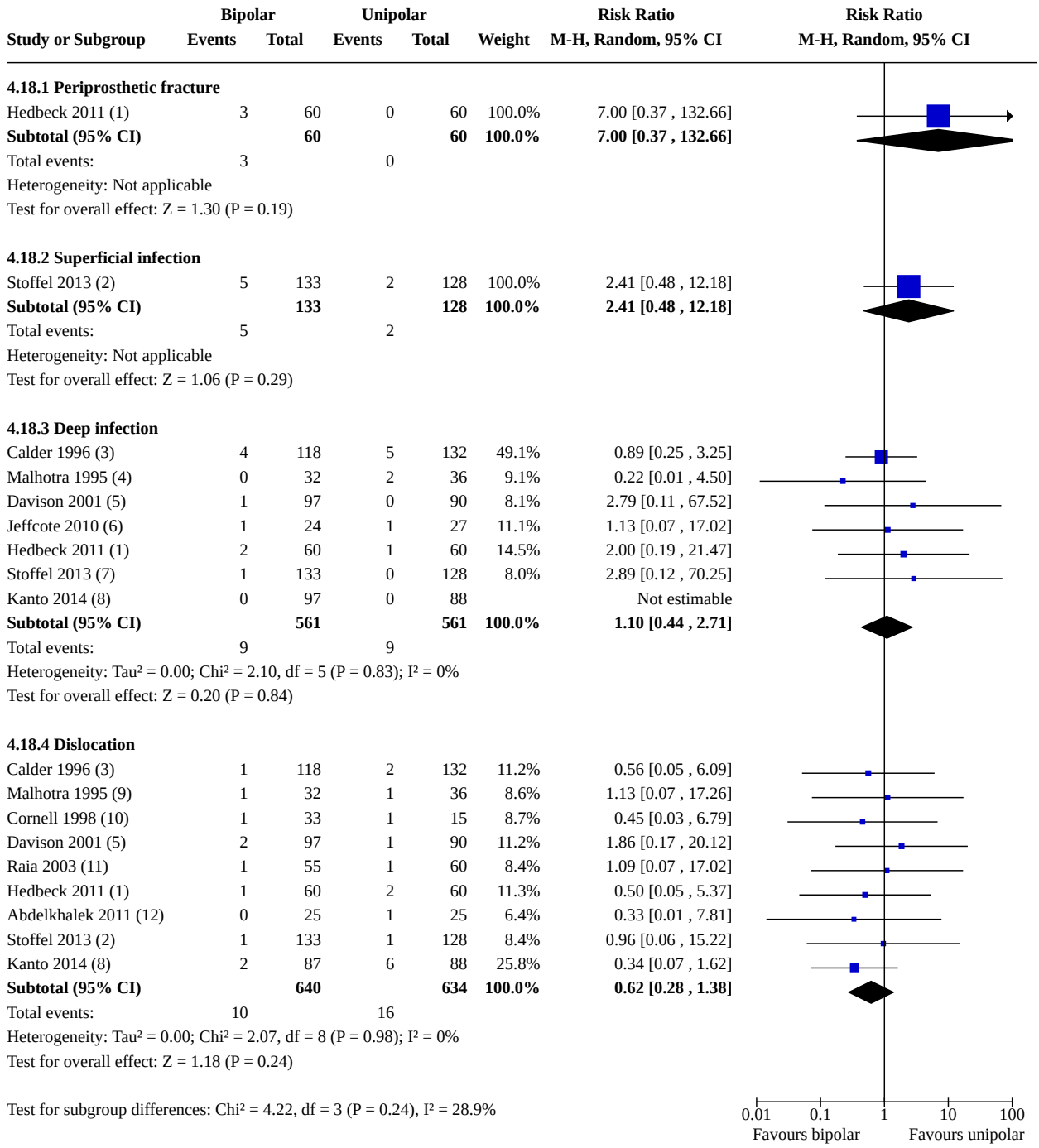
We found no evidence of a difference in unplanned return to theatre (RR 1.08, 95% CI 0.44 to 2.64, favours unipolar; 4 studies, 532 participants; I^2 = 31%; very low-certainty evidence; Analysis 4.13). Data were reported at the end of study follow-up which was at 12 months (Hedbeck 2011), 24 months (Abdelkhalek 2011), 48 months (Davison 2001), and 60 months (Kanto 2014). Some Indications for re-operations were dislocation, acetabular wear, pain, periprosthetic fracture or infection. We noted that types of re-operation included replacement with THA, revised HA, open reduction and drainage of infection. We downgraded the certainty of the evidence by one level for imprecision because we noted a wide CI in the effect estimate, and two levels for study limitations because the studies were at high risk of detection bias and had high and unclear risks of bias in other domains.

Other important outcomes

We found no evidence of a difference in pain when reported using categorical data, although one small study that used a numerical rating score to measure this outcome found that pain was reduced when a bipolar articulation was used. We found no evidence of a difference according to the articulation of the HA for discharge destination. We also found no evidence of a difference in adverse events related to the implant or fracture, or both (periprosthetic fracture, deep infection, superficial infection, dislocation) (Figure 5), or in adverse events unrelated to the implant or fracture, or both (acute kidney injury, blood transfusion, cerebrovascular accident, chest infection/pneumonia, myocardial infarction, urinary tract

infection, deep vein thrombosis, and pulmonary embolism). We report the summary effects of all these important outcomes and adverse effects in Table 11.

Figure 5. Bipolar hemiarthroplasty versus unipolar hemiarthroplasty. Forest plot for adverse events related to the implant, fracture, or both



Footnotes

(1) HA1: cemented, UHR Stryker, bipolar; HA2: cemented, Exeter modular, unipolar; at 12 months
(2) HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 months
(3) HA1: cemented, Monk, bipolar; HA2: cemented, Thompson; at 24 months
(4) HA1: uncemented, Bateman type, bipolar; HA2: uncemented; Austin-Moore; unipolar; at 2 years
(5) HA1: cemented, Monk, bipolar; HA2: cemented, Thompson; at 36 months
(6) HA1: cemented, Centrax, bipolar; HA2: cemented, Unitrax; unipolar; 24 months
(7) HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 months
(8) HA1: cemented, vario cup, bipolar; HA2: cemented, Lubinus, unipolar; at 60 months

Figure 5. (Continued)

(7) HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 months
(8) HA1: cemented, vario cup, bipolar; HA2: cemented, Lubinus, unipolar; at 60 months
(9) HA1: uncemented, Bateman type, bipolar; HA2: uncemented; Austin-Moore; unipolar; first week after surgery
(10) HA1: cemented, modular, bipolar; HA2: cemented, modular, unipolar; at 6 months
(11) HA1: cemented, Centrax, bipolar; HA2: cemented, Unitrax, unipolar; at 12 months
(12) HA1: mixed cemented/uncemented, bipolar; mixed cemented/uncemented, unipolar; at 48 months

Sensitivity analysis

High or unclear risk of selection bias (for sequence generation)

We excluded studies with high or unclear risk of selection bias from the primary analyses. This did not alter our interpretation of the effect for any outcomes.

High risk of attrition bias

No studies in this comparison group were at high risk of attrition bias.

3. HAs versus other HAs

Here we present three comparisons that evaluate one design of HA with another design: short stem versus long stem; Thompson versus Exeter Trauma Stem; Moore versus Furlong. A summary of the implant and study characteristics is presented in Table 5.

For each of these comparisons, we report here the effects for critical outcomes and we summarise the effects of other important outcomes in a table. All outcomes in these three comparisons are reported without GRADE assessment. For outcomes measured with scales, we present range of scores and direction of effect for each scale in Appendix 3.

HA: short stem versus standard stem

This comparison includes data from only one study with 151 participants (Lim 2020).

Critical outcomes

ADL, delirium, functional status, HRQoL, and unplanned return to theatre

Lim 2020 did not report data for these outcomes.

Mobility

Lim 2020 measured this outcome using dichotomised Koval's categories (see Appendix 3). We found no evidence of a difference in mobility at two years according to whether a short or standard stem was used (RR 0.98, 95% CI 0.72 to 1.34, favours standard stem; 1 study, 75 participants; Analysis 5.1).

Mortality

Lim 2020 reported data for mortality at 24 months. The estimate was very imprecise; we found no evidence of a difference in mortality two years after surgery (RR 0.77, 95% CI 0.43 to 1.37, favours short stem; 1 study, 151 participants; Analysis 5.2).

Other important outcomes

We found no evidence of a difference in pain according to whether a short stem or standard stem was used. We found no evidence of a difference in adverse events related to the implant or fracture, or both, according to whether a short stem or a standard stem was used (postoperative periprosthetic fracture, loosening, superficial infection, and dislocation). We report the summary effects of all these important outcomes and adverse effects in Table 12.

HA: Exeter Trauma Stem (ETS) versus Thompson

This comparison includes two studies with 1164 participants (Parker 2012; Sims 2018).

Critical outcomes

ADL and functional status

Neither study reported data for these outcomes.

Delirium

Parker 2012 reported delirium; the estimate was very imprecise such that no meaningful inference was possible (RR 5.00, 95% CI 0.24 to 102.85, favours Thompson; 1 study, 200 participants; Analysis 6.1).

HRQoL

Sims 2018 reported HRQoL at four months, measured using EQ-5D, in which higher scores indicate better HRQoL. We found that HRQoL was slightly improved when an ETS was used (MD 0.06, 95% CI 0.00 to 0.11, favours ETS; 1 study, 618 participants; Analysis 6.2). We noted that the CI is compatible with no difference or a small clinically important benefit with an ETS, based on a MCID of 0.07 (Walters 2005).

Mobility

Sims 2018 reported mobility, using categorical data according to whether participants could walk outdoors with or without a walking stick. We combined data for those that were freely mobile or able to walk outdoors with one walking stick, and found no evidence of a difference according to whether an ETS or a Thompson HA was used (RR 1.14, 95% CI 0.83 to 1.57, favours ETS; 1 study, 494 participants; Analysis 6.3). We report data for other categories in Appendix 6.

In addition, Parker 2012 reported mean change in mobility at 3 months and 12 months after surgery. We did not calculate effect estimates for this study because the data were reported without an appropriate measure of variance. See Appendix 7 for mean scores as reported by study authors.

Mortality

Both studies reported mortality.

Early:

- The estimate of this effect was imprecise, including clinically relevant benefits and harms. We found no evidence of a difference in mortality at up to four months from surgery (RR 1.20, 95% CI 0.76 to 1.88, favours Thompson; 2 studies, 1164 participants; I^2 = 45%; Analysis 6.4).

At 12 months:

- We also found no evidence of a difference in mortality at 12 months after surgery (RR 1.44, 95% CI 0.94 to 2.21, favours Thompson; 1 study, 200 participants; Analysis 6.5).

Unplanned return to theatre

Both studies reported unplanned return to theatre. We found no evidence of a difference in unplanned return to theatre (RR 0.46, 95% CI 0.05 to 3.89, favours ETS; 2 studies, 1164 participants; I^2 = 45%; Analysis 6.6). Re-operations were due to dislocation and acetabular wear, and resolved with revision of the HA.

Other important outcomes

We found no evidence of a difference in adverse events related to the implant or fracture, or both, according to whether an ETS or a Thompson HA was used (intraoperative periprosthetic fracture, deep or superficial infection, dislocation). We also found no evidence of a difference in adverse events unrelated to the implant or fracture, or both, according to whether a Thompson HA or ETS was used (acute kidney injury, blood transfusion, cerebrovascular accident, chest infection/pneumonia, myocardial infarction, DVT, or pulmonary embolism). We report the summary effects for these adverse events in Table 13. Additional outcome data for pain and length of stay is included in Appendix 7, since these data were reported without appropriate measures of variance such that we could not calculate effect estimates.

Sensitivity analysis

We excluded Parker 2012 from the primary analysis of early mortality (at ≤ four months) and unplanned return to theatre because the study was at unclear risk of selection bias (for sequence generation). This did not alter our interpretation of the effect for these outcomes. Neither study in this comparison was at high risk of attrition bias.

HA: hydroxyapatite (HAC)-coated Furlong versus Moore

This comparison includes one study with 82 participants and compares a first generation with a modern uncemented HA (Livesley 1993).

Critical outcomes

ADL, delirium, HRQoL, and mobility

Livesley 1993 did not report data for these outcomes.

Functional status

Livesley 1993 used a five-point hip function assessment according to Benjamin 1990 to evaluate functional status at 12 months (higher scores indicate better function). We did not calculate effect estimates for this study because data were reported without an appropriate measure of variance. The study authors reported a mean of 33.0 for participants who had a Furlong prosthesis, and a mean of 27.3 for participants who had a Moore prosthesis.

Mortality

Early:

- This effect estimate was imprecise. We found no evidence of a difference in mortality according to whether a Furlong or Moore HA was used (RR 0.35, 95% CI 0.07 to 1.82, favours Furlong; 1 study, 82 participants; Analysis 7.1).

At 12 months:

- Similarly, we found an imprecise estimate at 12 months. There was no evidence of a difference in mortality according to the type of prosthesis (RR 0.81, 95% CI 0.46 to 1.43, favours Furlong; 1 study, 82 participants; Analysis 7.2).

Unplanned return to theatre

Livesley 1993 reported unplanned return to theatre. The estimate was very imprecise, precluding meaningful interpretation. We found no evidence of a difference in mortality according to the type of prosthesis (RR 1.42, 95% CI 0.13 to 15.00, favours Moore; 1 study, 82 participants; Analysis 7.3). Re-operations were because of pain, periprosthetic fracture, or infection. The types of re-operation were not reported.

Other important outcomes

We found no evidence of a difference in pain at rest, or in adverse events related to the implant or fracture according to the type of prosthesis (periprosthetic fracture, superficial infection, or dislocation). We report the summary effects for these adverse events in Table 14.

4. THA versus HA

This comparison includes 17 studies with 3232 participants (Baker 2006; Blomfeldt 2007; Cadossi 2013; Chammout 2019; Dorr 1986; HEALTH 2019; Iorio 2019; Keating 2006; Macaulay 2008; Mouzopoulos 2008; Parker 2019; Ravikumar 2000; Ren 2017; Sharma 2016; Sonaje 2017; Van den Bekerom 2010; Xu 2017). A summary of the implant and study characteristics is presented in Table 6. Whilst most designs of HA used in this comparison were modern, one study included a first generation uncemented HA (Ravikumar 2000), and Sharma 2016 did not specify whether a first generation or modern design was used.

Here we report effects for critical outcomes. Where analyses included at least one study in each category, we subgrouped the analysis according to whether studies used a first generation or modern HA stem design in one of the intervention groups.

We used GRADE to assess the certainty of the evidence for the critical outcomes measured within four months of surgery (ADL, functional status, HRQoL, and mobility), within four months and at 12 months for mortality, and at the end of follow-up for delirium and unplanned return to theatre. See Summary of findings 3.

We summarise the effects of other important review outcomes in a table, which are not subgrouped by stem design, and these outcomes are reported without GRADE assessments. For outcomes measured with scales, we present range of scores and direction of effect for each scale in Appendix 3.

Critical outcomes

ADL

Four studies reported performance of ADL (Blomfeldt 2007; Chammout 2019; Mouzopoulos 2008; Parker 2019).

Early:

- We could only combine data from two of the studies. Blomfeldt 2007 used the Katz Index to identify participants that were independent (Katz 1963), and Chammout 2019 did not describe a measurement tool for this outcome. We found evidence that any difference in the number of people who were independent in ADL within four months of surgery is likely to be small (RR 1.03, 95% CI 0.91 to 1.18, favours THA; 2 studies, 225 participants; I^2 = 0%; very low-certainty evidence; Analysis 8.1). We downgraded the certainty of the evidence by one level for imprecision because the evidence included few participants, and two levels for study limitations because one of the studies had unclear risks of selection bias, and we found during sensitivity analyses that this may influence the direction of the estimate.
- Parker 2019 used a social mobility scale, in which lower scores indicate more independence. We found no evidence of a difference in mobility at 3 months (MD -0.10, 95% CI -0.46 to 0.26, favours THA; 1 study, 83 participants; Analysis 8.2).

At 12 months:

- We also found no evidence of a difference in the number of people who were independent in ADL at 12 months in Blomfeldt 2007 and Chammout 2019 (RR 0.96, 95% CI 0.86 to 1.07, favours HA; 2 studies, 217 participants; I^2 = 0%; Analysis 8.3).
- We also considered data from two studies that used continuous data, measured at 12 months (Mouzopoulos 2008; Parker 2019). Parker 2019 used a social mobility scale, in which lower scores indicate more independence. Mouzopoulos 2008 used the Barthel Index, in which higher scores indicate more independence; accordingly, we inverted the data from Mouzopoulos 2008 in this analysis. However, we did not pool these data owing to substantial statistical heterogeneity (I^2= 80%). Data from individual studies are reported in Analysis 8.4.

Late:

- Mouzopoulos 2008 also reported data at four years from surgery, and we found no evidence of a difference in performance of ADL at this later time point (MD 5.70, 95% CI 0.21 to 11.19, favours THA; 1 study, 43 participants; very low-certainty evidence; Analysis 8.5).

Delirium

Two studies measured delirium at 12 months (Parker 2019; Van den Bekerom 2010). We found no evidence of a difference in delirium according to the type of arthroplasty (RR 1.41, 95% CI 0.60 to 3.33, favours HA; 2 studies, 357 participants; low-certainty evidence; Analysis 8.6). We downgraded the certainty of the evidence by two levels - one level for imprecision because we noted a wide CI in the effect, and one level for study limitations because of unclear risks of bias.

Functional status

Thirteen studies reported functional status, and all studies used modern stem designs in both intervention groups (Baker 2006; Blomfeldt 2007; Cadossi 2013; Chammout 2019; HEALTH 2019; Keating 2006; Macaulay 2008; Mouzopoulos 2008; Ren 2017; Sharma 2016; Sonaje 2017; Van den Bekerom 2010; Xu 2017).

Early:

- Blomfeldt 2007 and Chammout 2019 reported mean data within four months of surgery using the HHS, and Keating 2006 reported mean scores using the Johansen hip score; in both scales, higher scores indicate better function. We found improved function within four months of surgery in people who received a THA (SMD 0.27, 95% CI 0.07 to 0.47, favours THA; 3 studies, 395 participants; very low-certainty evidence; I^2 = 0%; Analysis 8.7). After converting this effect estimate to the HHS, there appeared to be no clinically important difference in functional status between THAs and HAs (MD 3.44, 95% CI 0.89 to 5.98); this was based on a MCID for HHS of 16 to 18 (Singh 2016).
- In addition, Cadossi 2013 reported function using the HHS. We could not calculate effect estimates for this study because data were reported without an appropriate measure of variance. See Appendix 8 for mean scores as reported by study authors.
- We downgraded the evidence by three levels to very low certainty - one level for imprecision because the evidence included few participants, and two levels for study limitations because some studies had high and unclear risks of bias, and we found during sensitivity analysis that the direction of effect estimate was influenced by these studies.

At 12 months:

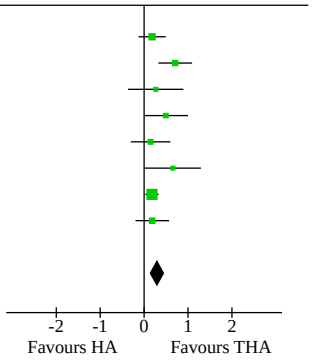
- Six studies reported functional status using the HHS, in which higher scores indicate better function (Blomfeldt 2007; Chammout 2019; Macaulay 2008; Mouzopoulos 2008; Sonaje 2017; Xu 2017); one study reported this outcome using the Johansen hip score in which higher scores indicate better function (Keating 2006); and one study reported this outcome using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) (HEALTH 2019). Because the WOMAC score has an opposite direction of effect (i.e. lower scores indicate better function), we inverted the data in HEALTH 2019. We found improved function at 12 months in people who had a THA (SMD 0.23, 95% CI 0.14 to 0.44, favours THA; 8 studies, 1273 participants; I^2 = 0%; Analysis 8.8; Figure 6). After converting this effect estimate to the HHS, there appeared to be no clinically important difference in functional status between THAs and HAs (MD 2.23, 95% CI 1.35 to 4.26); this was based on a MCID for HHS of 16 to 18 (Singh 2016).
- Ren 2017 and Sonaje 2017 reported categorical data using the HHS; ranges of scores were reported as excellent, good, medium, or poor, and we combined data for scores which were excellent and good. The time point of measurement was not reported in Ren 2017, and was at 24 months in Sonaje 2017. We found evidence that any difference in excellent and good scores is likely to be small (RR 1.07, 95% CI 0.98 to 1.17, favours THA; 2 studies, 140 participants; I^2 = 0%; Analysis 8.9). We report data for other categories in Appendix 6.
- In addition, three studies reported data at 12 months using the HHS (Cadossi 2013; Sharma 2016; Van den Bekerom 2010).

We did not calculate effect estimates for these studies because data were reported without an appropriate measure of variance. See Appendix 8 for mean scores as reported by study authors.

Figure 6. Total hip arthroplasty versus hemiarthroplasty. Forest plot of functional status at 12 months

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Std. Mean Difference IV, Random, 95% CI
Keating 2006 (1)	79.9	17	66	77.1	14	102	16.0%	0.18 [-0.13 , 0.49]
Blomfeldt 2007 (2)	87.2	9.4	56	79.4	12.3	55	11.7%	0.71 [0.32 , 1.09]
Macaulay 2008 (3)	84.2	12	17	80.6	14.3	23	5.0%	0.26 [-0.37 , 0.89]
Mouzopoulos 2008 (4)	81.6	4.9	33	77.81	9.6	30	7.5%	0.50 [-0.00 , 1.00]
Xu 2017 (5)	89.5	4.9	38	88.8	4.5	38	9.0%	0.15 [-0.30 , 0.60]
Sonaje 2017 (6)	88	5.76	20	83.85	6.62	20	4.9%	0.66 [0.02 , 1.29]
HEALTH 2019 (7)	-14.29	15.64	349	-17.22	16.99	320	34.2%	0.18 [0.03 , 0.33]
Chammout 2019 (8)	74	16	56	71	16	50	11.7%	0.19 [-0.20 , 0.57]
Total (95% CI)			**635**			**638**	**100.0%**	**0.29 [0.14 , 0.44]**

Heterogeneity: Tau² = 0.01; Chi² = 9.27, df = 7 (P = 0.23); I² = 25%
Test for overall effect: Z = 3.85 (P = 0.0001)
Test for subgroup differences: Not applicable



Footnotes

(1) Johansen hip score, function domain (higher score = better function); THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons
(2) HHS; THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28 mm bipolar; at 12 months
(3) HHS; THA: cement, stem, head (≥ 28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 12 months
(4) HHS; THA: Plus DePuy, no details; HA: Metete; no details; at 12 months
(5) HHS; THA: uncemented, no other details provided; HA: uncemented, bipolar; at 12 months
(6) HHS; THA: cemented, other details not reported; HA1: cemented, bipolar; at 24 months
(7) WOMAC (lower scores indicate better function; we inverted the data in meta-analysis); THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem
(8) HHS; THA: cemented, CPT stem, 32 mm head, cross linked polyethylene cup; HA: cemented, CPT stem, unipolar; at 12 months

Late:

- Three studies reported mean scores using the HHS at more than 24 months since surgery (Blomfeldt 2007; Mouzopoulos 2008; Xu 2017), and one study used the Oxford Hip Score (Baker 2006). Time points of measurement were at four years (Blomfeldt 2007; Mouzopoulos 2008), five years (Xu 2017), and nine years (Baker 2006). We found that hip function was improved when a THA was used (SMD 0.65, 95% CI 0.23 to 1.08, favours THA; 4 studies, 224 participants; I^2 = 56%; Analysis 8.10). We noted that this effect did not suggest a clinically important improvement in hip function (based on a MCID of 16 to 18 points; Singh 2016).
- In addition, two studies reported late data at three years using the HHS (Cadossi 2013), and at five years using the HHS (Van den Bekerom 2010). We did not calculate effect estimates for these studies because data were reported without an appropriate measure of variance. See Appendix 8 for mean scores as reported by study authors.

HRQoL

Five studies reported HRQoL (Baker 2006; Chammout 2019; HEALTH 2019; Keating 2006; Macaulay 2008).

Early:

- Two studies reported EQ-5D at four months after surgery (Chammout 2019; Keating 2006); in this scale, higher scores indicate improved quality of life. We found no evidence of a difference in HRQoL at four months after surgery according to the type of arthroplasty (MD 0.03, 95% CI -0.06 to 0.12, favours THA; 2 studies, 279 participants; I^2 = 51%; very low-certainty evidence; Analysis 8.11). We downgraded the certainty of the evidence by three levels - two levels for imprecision because the evidence was compatible with no difference and a clinically meaningful difference (based on a MCID for EQ-5D of 0.07; Walters 2005), and one level for study limitations because studies had high and unclear risks of bias.

At 12 months:

- Four studies reported this outcome at 12 months using EQ-5D (Chammout 2019; HEALTH 2019; Keating 2006), or SF-36 (Macaulay 2008); in both scales, higher scores indicate improved quality of life. We found that HRQoL at 12 months was improved when a THA was used (SMD 0.19, 95% CI 0.07 to 0.31, favours THA; 4 studies, 1158 participants; I^2 = 0%; moderate-certainty evidence; Analysis 8.12). After converting this effect estimate to the EQ-5D scale, it is likely that the evidence is most compatible with no clinically important difference in HRQoL between THAs and HAs (0.05, 95% CI 0.02 to 0.08): this was based on a MCID for EQ-5D of 0.07 (Walters 2005).

Late:

- In addition, one study also reported HRQoL using SF-36 at nine years (Baker 2006). This effect was imprecise; we found no evidence of a difference in health-related quality of life (MD 5.90, 95% CI -1.99 to 13.79, favours THA; 1 study, 34 participants; Analysis 8.13).

Mobility

Five studies reported mobility (Baker 2006; HEALTH 2019; Macaulay 2008; Parker 2019; Ravikumar 2000).

Early:

- Parker 2019 used a nine-point mobility scale, with lower scores indicating better mobility. We found no evidence of a difference in mobility at three months after surgery (MD -0.40, 95% CI -0.96 to 0.16, favours THA; 1 study, 83 participants; low-certainty evidence; Analysis 8.14). We downgraded the evidence by one level for imprecision because the evidence included few participants, and one level for study limitations because the study included unclear risks of bias.
- Dorr 1986 reported mobility using a six-point scale to describe ambulation. We did not calculate effect estimates for this study because data were reported without an appropriate measure of variance. See Appendix 8 for mean scores as reported by study authors.

At 12 months:

- We combined data from two studies which used the Timed Up and Go (TUG) test to measure mobility (Macaulay 2008; HEALTH 2019); lower values (a shorter length of time) indicate better mobility. We found no evidence of a difference in mobility (MD -2.74, 95% CI -6.82 to 1.35, favours THA; 2 studies, 575 participants; I^2 = 9%; Analysis 8.15).
- Parker 2019 used a nine-point mobility scale, with lower scores indicating better mobility. We found no evidence of a difference in mobility according to the type of arthroplasty (MD 0.40, 95% CI -0.32 to 1.12, favours HA; 1 study, 78 participants; Analysis 8.16).
- Macaulay 2008 and Ravikumar 2000 reported the number of people who were able to ambulate independently at 12 months. We also found no evidence of a difference according to the type of arthroplasty with this mobility measure (RR 0.96, 95% CI 0.71 to 1.31, favours HA; 2 studies, 175 participants; I^2 = 49%; Analysis 8.17).
- In addition, one study reported mobility using a six-point scale to describe ambulation (Dorr 1986). We did not calculate effect estimates for this study because data were reported without an appropriate measure of variance. See Appendix 8 for mean scores as reported by study authors.

Late:

- Ravikumar 2000 also reported the number of people able to ambulate independently at the end of the study follow-up, which was at 13 years. We found no evidence of a difference in mobility according to the type of arthroplasty (RR 1.27, 95% CI 0.71 to 2.29, favours THA; 1 study, 32 participants; Analysis 8.18).

Mortality

Fourteen studies reported mortality (Baker 2006; Blomfeldt 2007; Cadossi 2013; Chammout 2019; HEALTH 2019; Iorio 2019; Keating 2006; Macaulay 2008; Mouzopoulos 2008; Parker 2019; Ravikumar 2000; Sharma 2016; Van den Bekerom 2010; Xu 2017).

Early:

- The effect estimate for mortality within four months of surgery was very imprecise, including clinically relevant benefits and harms. We found no evidence of a difference (RR 0.77, 95% CI 0.42 to 1.42, favours THA; 6 studies, 725 participants; I^2 = 0%; very low-certainty evidence; Analysis 8.19). We downgraded the certainty of the evidence by two levels for imprecision because the wide CI included relevant benefits and harms, and one level for study limitations because included studies had high and unclear risks of bias.

At 12 months:

- We found no evidence of a difference in mortality at 12 months from surgery according to the type of arthroplasty (RR 1.00, 95% CI 0.83 to 1.22, favours THA; 11 studies, 2667 participants; I^2 = 0%; moderate-certainty evidence; Analysis 8.20). We downgraded the certainty of the evidence by one level because included studies had high and unclear risks of bias. We generated a funnel plot which showed no evidence of publication bias from visual inspection; we also found no statistical evidence of small study size effects (Harbord modified test, P value = 0.966).

Late:

- Seven studies reported a late follow-up after surgery. These data were reported at 36 months (Cadossi 2013), 39 months (Baker 2006), 48 months (Blomfeldt 2007; Mouzopoulos 2008), 60 months (Van den Bekerom 2010; Xu 2017), and 13 years (Ravikumar 2000). We found no evidence of a difference at this late follow-up according to the type of arthroplasty (RR 1.00, 95% CI 0.81 to 1.23, favours HA; 7 studies, 891 participants; I^2 = 46%; Analysis 8.21).

Unplanned return to theatre

Ten studies reported unplanned return to theatre, which was reported at 12 months (Iorio 2019, Parker 2019), 24 months (Chammout 2019; HEALTH 2019, Keating 2006), 39 months (Baker 2006), 48 months (Dorr 1986; Mouzopoulos 2008), 60 months (Van den Bekerom 2010), and 13 years (Ravikumar 2000). We found no evidence of a difference in unplanned return to theatre according to the type of arthroplasty (RR 0.63, 95% CI 0.37 to 1.07, favours THA; 10 studies, 2594 participants; I^2 = 40%; low-certainty evidence; Analysis 8.22). Some re-operations were because of dislocation, acetabular wear, pain, periprosthetic fracture or infection. We noted that types of re-operation included replacement with THA, revised HA, open reduction, and drainage of infection. We downgraded the certainty of the evidence by one level for imprecision because the wide CI was consistent with both benefit and harms, and one level for study limitations because the evidence included studies with high and unclear risks of bias which included high risks of detection bias.

Other important outcomes

We found substantial levels of statistical heterogeneity in data for some pain outcomes, and did pool data in these instances. We found no evidence of a difference in discharge destination according to the type of arthroplasty. We also found no evidence of a difference in adverse events related to the implant or fracture, or both (periprosthetic fracture, loosening, deep infection, superficial infection, dislocation) or in adverse events unrelated to the implant or fracture, or both (acute kidney injury, cerebrovascular accident, chest infection/pneumonia, myocardial infarction, urinary tract infection, deep vein thrombosis, and pulmonary embolism). We found that fewer participants had a blood transfusion when a HA was used; however, this analysis was from only two small studies. We report the summary effects of all these important outcomes and adverse effects in Table 15.

Sensitivity analysis

We performed sensitivity analysis on critical outcomes in which data were available from more than one study for risk of bias judgements (sequence generation and attrition bias). We did not perform sensitivity analysis on mixed populations because most studies reported insufficient information for us to judge whether participants' characteristics in the included studies were mixed. We did not perform sensitivity analysis according to whether interventions are no longer in current use since this was not relevant.

Here, we report the findings of sensitivity analyses only for those outcomes in which we noted an effect which differed in interpretation to the primary analysis.

High or unclear risk of selection bias (for sequence generation)

- Early ADL (≤ 4 months; categorical data): we excluded Blomfeldt 2007 from the primary analysis. Only one study remained in analysis. Although the estimate continued to show no evidence of a difference in performance of ADL, we noted the direction favoured the alternative intervention (RR 1.00, 95% CI 0.78 to 1.29, favours HA; 1 study, 111 participants).
- Early functional status (≤ 4 months; continuous data): we excluded Blomfeldt 2007 and Keating 2006 from the primary analysis. Only one study remained in analysis; this estimate no longer indicated a benefit in favour of HA (MD 1.00, 95% CI -4.03 to 6.03; 1 study, 111 participants).
- Late functional status (at > 24 months): we excluded two studies from the primary analysis (Blomfeldt 2007; Mouzopoulos 2008), and found that the effect estimate no longer demonstrated an improvement in hip function when THA was used (MD 4.83, 95% CI 0.48 to 9.18; 1 study, 64 participants).
- Early HRQoL (≤ 4 months): we excluded Keating 2006 from the primary analysis. Only one study remained in analysis. Although the estimate continued to show no evidence of a difference in early HRQoL, we noted the direction favoured the alternative intervention (MD -0.02, 95% CI -0.11 to 0.07, favours HA; 1 study, 111 participants).

High risk of attrition bias

- HRQoL (at 12 months): we excluded HEALTH 2019 from the primary analysis, including only studies at low risk of attrition bias for this outcome. We found that the effect estimate no longer showed evidence of a difference between interventions (SMD 0.17, 95% CI -0.05 to 0.40; 4 studies, 314 participants; I^2 = 0%).

5. Single versus multiple articulations of THA

This comparison included two studies with 83 participants in which a standard cup (single articulation) was compared to a dual-mobility cup (Griffin 2016; Rashed 2020). A summary of the implant and study characteristics is presented in Table 7. For outcomes measured with scales, we present range of scores and direction of effect for each scale in Appendix 3.

Critical outcomes

ADL, delirium, mobility, and unplanned return to theatre

Neither study reported data for these outcomes.

Functional status

This outcome was measured using the Oxford Hip Score in Griffin 2016, and the HHS in Rashed 2020. In both scales, higher scores indicate better function.

Early:

- We found no evidence of a difference in functional status within four months of surgery according to the articulation type (SMD -0.33, 95% CI -0.78 to 0.12, favours dual-mobility; 2 studies, 78 participants; I^2 = 0%; Analysis 9.1).

At 12 months:

- When measured at 12 months, we found that functional status was improved when a dual-mobility cup was used (SMD -0.60, 95% CI -1.05 to -0.15, favours dual-mobility; 2 studies, 79 participants; I^2 = 0%; Analysis 9.2).

HRQoL

Only one study reported HRQoL (Griffin 2016). This was measured using EQ-5D, with a range of scores from 0 to 1 (higher scores indicate better quality of life).

Early:

- We found no evidence of a difference in HRQoL at four months after surgery according to the articulation (MD 0.24, 95% CI -0.21 to 0.69, favours single articulation; 1 study, 16 participants; Analysis 9.3).

At 12 months:

- We found improved HRQoL at 12 months after surgery when a standard cup was used (MD 0.30, 95% CI 0.08 to 0.52, favours single articulation; 1 study, 19 participants; Analysis 9.3).

Mortality

Both studies reported mortality (Griffin 2016; Rashed 2020). We found no evidence of a difference in mortality at 12 months after surgery according to whether a dual-mobility cup or a standard cup was used with the THA (RR 0.62, 95% CI 0.08 to 4.77, favours single articulation; 2 studies, 82 participants; I^2 = 0%; Analysis 9.4).

Other important outcomes

We found no evidence of a difference in adverse events related to the implant or fracture, or both (deep infection, superficial infection, and dislocation); we noted zero events for dislocation from two small studies. We also found no evidence of a difference in adverse events unrelated to the implant or fracture, or both (DVT). We report the summary statistics for these adverse events in Table 16.

6. Short stem versus standard stem of THA

This comparison includes only one study with 161 participants, comparing a short stem THA with a standard stem (Kim 2012). A summary of the implant and study characteristics is presented in Table 7. For outcomes measured with scales, we present range of scores and direction of effect for each scale in Appendix 3.

Critical outcomes

ADL, delirium, HRQoL, and unplanned return to theatre

Kim 2012 did not report data for these outcomes.

Functional status

Kim 2012 reported functional status measured using the HHS. We found no evidence of a difference in functional status at 24 months after surgery according to whether a short or standard stem was used in the THA, when measured with the HHS (MD -0.40, 95% CI -3.19 to 2.39, favours standard stem; 1 study, 140 participants; Analysis 10.1).

Mobility

Kim 2012 reported mobility using categorical data according to distance walked (walks > six blocks with or without aids, walks < six blocks, walks indoors only). We found no evidence of a difference in being able to walk more than six blocks with or without aids at 24 months according to whether a short or standard stem was used in the THA (RR 1.10, 95% CI 0.84 to 1.44, favours short stem; 1 study, 424 participants; Analysis 10.2). We report data for other categories in Appendix 6.

Mortality

We found no evidence of a difference in mortality at 12 months from surgery according to whether a short or standard stem was used in the THA (RR 1.20, 95% CI 0.38 to 3.78, favours standard stem; 1 study, 161 participants; Analysis 10.3).

Other important outcomes

We found no evidence of a difference in pain according to whether a short or standard stem was used. We found no evidence of a difference in some adverse events related to the implant or fracture, or both (superficial infection and dislocation), and for adverse events unrelated to the implant or fracture, or both (acute kidney injury, pneumonia, urinary tract infection). We noted fewer intraoperative periprosthetic fractures when a short stem was used, but, as for all adverse events, data were available from only one small study (Kim 2012). We report the summary effects of important outcomes and adverse events in Table 17.

DISCUSSION

Summary of main results

We included 58 studies (50 RCTs, eight quasi-RCTs) with 10,654 participants with 10,662 hip fractures. All hip fractures were intracapsular, except in one study that included only extracapsular fractures. We also identified seven ongoing studies with an estimated recruitment of 7199 participants.

We found evidence for 10 different comparisons of types of arthroplasties. We report below the main findings of three of these comparisons, representing the most substantial bodies of evidence in the review.

Cemented versus uncemented HA (17 studies, 3644 participants)

Eight studies compared cemented prostheses with first-generation uncemented prostheses, and nine studies with modern uncemented prostheses. Moderate-certainty evidence indicated no clinically important difference between interventions in performance of ADL and independent mobility at four months. The estimates for treatment effects in delirium, the risk of mortality within four months of surgery, and unplanned return to theatre were imprecise, of low certainty, and compatible with clinically relevant benefits and harms. There were, however, statistically significant benefits with cemented prostheses in HRQoL at 4 months, and mortality at 12 months, with moderate-certainty evidence. The magnitude of these effects were compatible with small to large benefits. The evidence for function was of very low certainty, and although the estimate included benefits and harms, these were not clinically important. Subgroup analysis by uncemented prosthesis design suggested that the mortality benefit from cemented prostheses cannot be explained by higher mortality reported in the uncemented group from studies including first-generation prostheses.

There was no difference in the overall risk of adverse events. However, within this overall risk profile, we found evidence that the risk of intra- and postoperative periprosthetic fracture was lower with cemented HA, but the risk of pulmonary embolic events was greater.

We analysed the data for extracapsular fractures separately, and found very low-certainty evidence of an improvement in functional status within four months of surgery. This difference may be clinically important.

Bipolar HA versus unipolar HA (13 studies, 1499 participants)

Prostheses were fixed with cement in nine studies, and without cement in three studies. No studies reported performance of ADL or functional status within four months of surgery. For the outcomes of delirium, HRQoL within four months of surgery, and unplanned return to theatre, the evidence was of very low certainty, and plausibly included clinically relevant benefits and harms. For mortality at both 4 and 12 months from surgery, the evidence was of low certainty, and plausibly included clinically relevant benefits and harms.

We found no difference in the overall risk of adverse events.

THA versus HA (17 studies, 3232 participants)

We found very low-certainty evidence in performance of ADL and HRQoL; the findings were compatible both with no effect and a clinically relevant improvement. Similarly, the moderate-certainty evidence for mortality at 12 months plausibly included clinically relevant benefits and harms. These findings were the same for delirium, mortality at four months, and unplanned return to theatre, but were supported by low-certainty evidence. For functional status, we noted that an improvement which favoured THA was not clinically important, and that this evidence was of very low certainty.

We found no difference in the overall risk of adverse events.

Other comparisons, which had fewer participants contributing to the available evidence and for which the estimates were generally too imprecise to yield meaningful inferences, were between: cemented and uncemented THAs; a combination of THAs and HAs which were cemented or uncemented; short or standard stem HAs; Exeter Trauma Stem or Thompson HAs; Furlong or Austin-Moore

HAs; single- or dual-mobility articulations of THA; and short or standard stem THAs.

Overall completeness and applicability of evidence

We included 58 studies with 10,654 participants with a hip fracture. Most of our evidence is applicable only to people with intracapsular fractures as only one of the studies included participants with extracapsular fractures. Most extracapsular fractures are treated primarily with fixation rather than arthroplasty. Where reported, we noted a range of mean ages from 63 years to 87 years, and 73% of participants were female. We expected that most studies would include some participants with cognitive impairment, although approximately one-third of studies excluded participants with cognitive impairment. Studies did not consistently report American Society of Anesthesiologists (ASA) status scores to indicate participants' fitness for surgery. In general, we assess that the review includes participants who are largely representative of the general hip fracture population undergoing arthroplasty surgery.

The studies reported outcomes following interventions that are all still in use worldwide. We recognise that there is variation in practice in different countries. The provision of cemented or modern uncemented HA and THA treatments may be particularly variable across different resource settings. We assess that the findings of this review are therefore applicable only to the countries in which studies were conducted, of which two-thirds were in European and western countries.

The included studies were conducted between 1977 and 2020. There have been very substantial changes in co-interventions in hip fracture care over this period of time. This may mean that, in older studies, the absolute effects are not directly applicable to contemporary care, but we found no evidence that the relative effects varied across time. Therefore, we assess that the historical literature is relevant and appropriate for pooling with more contemporary studies.

We identified studies that evaluated most of our clinically relevant, prespecified comparisons. The majority of studies provided evidence for one of three major groups of comparisons: cemented versus uncemented HAs; unipolar versus bipolar HAs; and THA versus HA. Even within these comparisons, with relatively more included studies, we found that many did not report fully outcomes such as performance of ADL or HRQoL. These are key components of the core outcome set for hip fracture, and yet our ability to draw inferences on the effect of interventions on these outcomes was limited. However, mortality was generally well-reported, an outcome that is valued by individuals and clinicians in assessing intervention effects.

We were unable to fully perform our prespecified subgroup analyses to explore the impact of specific participant characteristics on the outcomes, such as the effect of age or cognitive impairment, since study characteristics were inconsistently reported within and between studies.

We prioritised short-term outcomes in this review. We attempted to explore the longer-term outcomes of the interventions, adding a long-term measure of outcomes after 24 months from surgery. Longer-term outcome could help to determine cost-benefit decisions around intervention choices. Although some studies did present longer-term data, these findings were often less precise due to attrition from death in this older, frail population.

Quality of the evidence

We used GRADE to formally assess the certainty of the evidence for the critical outcomes for the three main comparisons. The certainty of the evidence ranged from moderate to very low certainty. This was often due to imprecision in the estimate and the risk of bias in the included studies.

We judged several studies to have unclear risk of selection bias because they did not provide information about the allocation methods, or high risk of selection bias because they used quasi-randomised methods to allocate participants to groups. We used sensitivity analysis to explore this, and found that re-analysing the data without these studies sometimes influenced the effect: either importantly changing the size of the effect by including or excluding clinically relevant effects, or even changing the direction of the effect. All outcomes in the analyses of our main comparisons included studies with unclear or high risks of selection bias, and we therefore downgraded the certainty of the evidence for all outcomes in our main comparison groups owing to study limitations. We also downgraded the evidence for unplanned return to theatre because studies were at a high risk of detection bias for this outcome.

As well as the risks of bias, the majority of the studies had few participants, reported imprecise estimates, and were likely to be at high risk of a type II error (when a researcher may conclude that there is not a signficant effect when actually there is). The potential benefit of meta-analysis to overcome this limitation was confounded by the reporting of widely different sets of outcomes across the included studies. Approximately two-thirds of the studies predated the publication of the hip core outcome set which guided the selection of the critical outcomes in this review (Haywood 2014).

We did not downgrade for indirectness as the study populations and types of interventions were consistent with our intended criteria. We did not downgrade for inconsistency. We evaluated the risk of publication bias in only two analyses (in which we had more than 10 studies), and found no reason to downgrade for this potential limitation.

Potential biases in the review process

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

During the review process, we made changes to the methods, which we describe in Differences between protocol and review. The most significant change was to collect data at three time points rather than two time points. This reflected the wider than expected variation in the outcome time points in the included studies. We aggregated outcome data for the 12-months time point across a window between 4 and 24 months. Due to the high rates of attrition, we recognise that estimates based on later time points may systematically tend towards no effect. However, we believed it was important to report available data, but recognise that the decision may have influenced the pooled effect estimates.

Although data were sometimes more frequently reported after four months from surgery (typically at 12 months), we prioritised early outcomes in the summary of findings tables. The consequence of this decision is that some critical outcomes for the bipolar versus unipolar comparison have no data in the relevant table. However, this is consistent with our protocol, based on a core outcome set for hip fracture, which prioritises early outcomes over late recovery (Haywood 2014). We reached the decision to report mortality at two time points - within four months of surgery and at 12 months after surgery - following discussion with the Cochrane Bone, Joint, and Muscle Trauma Group. Mortality at 12 months still remains a more common time point reported by study authors, reflecting the expectations of organisations that fund research and journal editors.

Each of the interventions included in the review is complex: they are a combination of different design components which are not mutually exclusive. They are described more fully in Table 2. We made prespecified decisions in our protocol in stratifying our comparisons. This had most effect in the comparison of cemented and uncemented prostheses, where we had to divide the pooled analyses into those including studies of HA, THA, and a mixed intervention. This may have reduced the precision of some of the effect estimates by reducing the available studies in any one pooled analysis. However, the effects were largely concordant across the comparison, and we assess this to be unlikely to have substantially changed the inferences from the available data.

We did not explore adverse events related to implants beyond those described in the protocol for this review. We listed all outcomes reported by each study in the Characteristics of included studies, and these lists include additional adverse events for which we did not report data. Data for these additional adverse events for studies previously included are available in a previous version of this review (Parker 2010c). We attempted to collect information about the reasons for unplanned return to theatre, or the types of re-operation, but found that this information was not clearly reported in many of the studies. This limited our ability to comment further on these events.

Newer studies were typically reported more completely. However, the majority of the available data in this review are derived from the historical literature. Where possible, we have presented the data in chronological order to try to indicate visually if effect estimates have varied systematically with time. We recognise that there may be an interaction, too, with the changes in co-interventions with time.

We used GRADE only to assess the certainty of the evidence for the critical outcomes in this review that are included in our summary of findings tables. Therefore, we did not report any judgements of certainty for the remaining review outcomes. We highlighted this distinction when introducing the results for each comparison group. Given the risks of bias in all studies, as well as the imprecision in many of the findings, we anticipate that the certainty of most of these remaining review outcomes is likely to range from low to very low.

Agreements and disagreements with other studies or reviews

Although we found no recent comprehensive systematic reviews that evaluate all types of HA and THA within a single review, we found reviews comparing fixation techniques, articulations, and stem designs similar to the comparisons included in this Cochrane Review: cemented versus uncemented HAs (Azegami 2011; Imam 2019a), unipolar with bipolar HAs (Imam 2019b), and HA with THA (Hopley 2010; Lewis 2019; Liu 2020; Metcalfe 2019).

Azegami 2011 included eight RCTs, and reported the potential for reduced pain and improved mobility in cemented HAs compared to uncemented HAs. A more recent review of nine RCTS found no significant differences in pain or other complications, although the review authors observed that cemented HAs may lead to fewer intraoperative fractures (Imam 2019a). The improved mobility and reduction in intraoperative fractures is compatible with our findings. The reporting of pain in our included studies was highly variable, precluding effective pooling of studies, so that in this Cochrane Review, the reduction in pain in the cemented group was not evident. Whilst our data are compatible with this finding, they are also compatible with an alternative hypothesis that modern uncemented prostheses may yield reduced pain.

Imam 2019b included 13 RCTs and 17 observational studies, and found no significant difference in function and mortality between bipolar and unipolar HAs. Although review authors concluded that bipolar HAs lead to lower rates of re-operation, their analysis included observational studies. An analysis with only RCTs was consistent with our findings that the re-operation risk is similar with both interventions.

A larger number of reviews comparing HA to THA have been completed in recent years (Hopley 2010; Lewis 2019; Liu 2020; Metcalfe 2019). Results vary across the reviews, with reduced risk of re-operation and improved function being reported for THA in three reviews (Hopley 2010; Lewis 2019; Liu 2020). Metcalfe 2019 combined a meta-analysis of five RCTs with data from a comprehensive national cohort of hip fractures of 143,000 individuals, and reported no difference in re-operation rates or function, which reflects the findings in this review.

This review included two large multicentre studies. The findings of Fernandez 2022 for cemented compared to uncemented HAs, and of HEALTH 2019 for THA compared to HA, provide substantial data which are consistent with the findings in this review.

AUTHORS' CONCLUSIONS

Implications for practice

For people undergoing hemiarthroplasty for intracapsular hip fracture, it is likely that a cemented prosthesis will yield an improved global outcome, particularly in terms of clinically appreciable improvements in HRQoL and mortality. For every 26 people treated with a cemented hemiarthroplasty, one more person will be alive at 12 months following surgery.

Currently, there is insufficient evidence to determine whether a bipolar hemiarthroplasty yields different outcomes compared to a unipolar prosthesis. Both are appropriate treatments for people with intracapsular hip fracture.

Any benefit of THA compared with hemiarthroplasty is likely to be small and not clinically appreciable.

Implications for research

Considerable research resources have been and are being committed to this field; we identified seven ongoing studies that may contribute data in future review updates. It is unlikely that future research will importantly alter our inferences about the relative clinical effectiveness of cemented and uncemented HAs, which now include data from a large multicentre study (Fernandez 2022). There is a relative paucity of evidence available from generally small studies for the comparison of bipolar and unipolar hemiarthroplasty. The estimates of any difference between total hip arthroplasty and hemiarthroplasty for some of the critical outcomes are imprecise. However, available data provide little to suggest that any effect is likely to be clinically meaningful. This is consistent with the findings of the large, international HEALTH 2019 study, and suggests that repeating such a study may not yield high-value information.

We therefore encourage investigators interested in these comparisons to focus on conducting studies of alternative implant designs - such as dual mobility bearings - that are being incorporated widely into clinical practice, with scant evidence to support their use. We encourage investigators to address the limitations in the quality of the evidence in the field through better study design and clear reporting about methods of randomisation and allocation concealment, as well as attempting to minimise attrition for participant-reported outcomes. We raise the awareness amongst investigators of the core outcome set for hip fracture that should be included in every RCT in hip fracture (Haywood 2014). To date, few studies have considered patient-relevant outcomes, such as performance of activities of daily living, health-related quality of life, mobility, or delirium.

Given the recommendations in Haywood 2014, we recommend that future studies are large enough to detect differences in HRQoL. Having reviewed the included studies, we estimate that the standard deviation for EQ-5D at four months' post-diagnosis is approximately 0.3. Assuming a minimal clinically important difference of 0.07 (Walters 2005), and an observed attrition in the included studies approaching 40%, we recommend future samples of not less than 1000 participants in order to yield sufficiently precise estimates.

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CHARACTERISTICS OF STUDIES

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

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* Indicates the major publication for the study

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, or any baseline data for: smoking history, BMI, mobility assessment, place of residence, cognitive status, or preoperative waiting time. • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
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; losses not reported; analysed for all outcomes = 25 **Intervention group 2** • HA unipolar; 15 cemented Thompson; 10 Austin-Moore; further details not reported • Randomised = 25; losses not reported; analysed for all outcomes = 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:** HHS (categorical data: excellent, good, fair, poor); pain (categorical data: none, slight, mild, severe); dislocation; infection; DVT; unplanned return to theatre **Notes:** • time points not reported. Final follow-up ranged 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
Risk of bias	

Abdelkhalek 2011 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Alternately allocated to groups
Allocation concealment (selection bias)	High risk	Not possible to conceal alternate allocation
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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 nonpathological 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

Baker 2006 *(Continued)*

- 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), SF-36 MCS, mean (range): 55.52 (33.8 to 64.2)
- 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)
  - SF-36 PCS, mean (range): 44.35 (19.7 to 66.8), SF-36 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 (participant 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, hypnotremia **Outcomes relevant to the review:** mortality (at 9 years); dislocation; infection; venous thromboembolic phenomena (pulmonary emboli, and DVT); pneumonia; functional status (OHS); mobility (walking distance, participant reported); HRQoL (SF-36, PCS; at 9 years); unplanned return to theatre **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) • infection described as "wound infection", assumed to be superficial • we used data for HRQoL (SF-36, PCS) and functional status as reported in a previous version of the review in which SDs were calculated from P values (Parker 2010a)

Baker 2006 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** no grants or external funding **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	"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) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. 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) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) 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.
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.
Other bias	Low risk	We identified no other sources of bias.

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.

Blomfeldt 2007 *(Continued)*

Exclusion criteria: pathological fractures; displaced fractures present for > 48 hours before presentation; rheumatoid arthritis; osteoarthritis

Setting: single centre; hospital; Sweden

Intervention group 1 (THA)

- Age, mean (SD, range): 80.5 (± 5.1, 70.2 to 89.7) years
- Gender, M/F: 13/47
- Comorbidities, Ceder A or B (Ceder 1980), 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 (Ceder 1980), 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.
- Study authors reported no difference between baseline groups.

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 and complications = 60; analysed for ADL, HHS and pain at 4 months = 58; analysed for HHS at 48 months = 55; analysed for ADL, HHS and pain at 12 months = 56; analysed for HHS and pain at 48 months = 42 **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 for mortality and complications = 60; analysed for HHS and pain at 4 months = 58; analysed for ADL at 4 months = 56; analysed for ADL, HHS and at 12 months = 55; analysed for HHS and pain at 48 months = 41
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, pul-

Blomfeldt 2007 *(Continued)*

	monary, 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); ADL (Katz) number categorised as A or B (at 4 months and 12 months); functional status (using HHS; at 4 months, 12 months and 48 months); pain (using HHS; at 4 months, 12 months, and 48 months); loosening (12 months); complications (DVT; MI; pneumonia; at 4 months); dislocation (12 months); perioperative complications (superficial infection) **Notes:** • We used data from an associated publication by Hedbeck and colleagues for mortality, functional status and pain at 48 months. • 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.
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) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeons in the study were experienced in both techniques, and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of 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.
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 2007 *(Continued)*

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

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 participants 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 for mortality and loosening = 38; analysed for other outcomes = 31 **Intervention group 2**

Brandfoot 2000 *(Continued)*

- HA uncemented Thompson
- Randomised = 53; 14 died; analysed for mortality and loosening = 53; analysed for other outcomes = 39

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, loosening; total function scores; mobility; ADL (using modified HHS for activities: stairs, shoes, socks, bath; higher scores indicate more independence); pain; all 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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report seniority of staff involved in the surgery but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) 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.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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
	
	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; 5 excluded (PCU and metal back), other losses not explained; analysed for mortality at 3 years = 47; analysed for HHS and pain at 3 months = 37; analyed for HHS and pain at 12 months = 36; analysed for HHS and pain at 36 months = 16; length of stay = 41 **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)

Cadossi 2013 *(Continued)*

- Randomised = 49; 8 excluded (dementia, poor mobility, internal fixation), other losses not explained; analysed for mortality at 3 years = 49; analyed for HHS and pain at 3 months = 37; analyed for HHS and pain at 12 months = 33; analysed for HHS and pain at 36 months = 16; length of stay = 41

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), functional status (using HHS; at 3 months, 12 months, and 3 years), pain (using HHS at 3 months, 12 months, 3 years), length of stay in hospital **Note:** • We did not report outcome data for unplanned return to theatre which was reported clearly in the THA group, but we could not be certain whether it was reported for all participants in the HA group. Similarly, we did not include outcome data for dislocation because we could not be certain whether it was reported for participants in the HA group.
Notes	**Funding/sponsor/declarations of interest:** no external funding **Study dates:** March 2008 to April 2010

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	Described as sealed envelopes, no further details
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were all performed by experienced staff, but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	For functional status and pain, we noted a large number of losses in each group; some losses could be explained by death but other losses are not explained.

Cadossi 2013 *(Continued)*

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

Calder 1995

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: bipolar vs unipolar Note: • study included a third study arm (Ambi Hip Screw) which we did not include in this review • 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**: 73 (total randomised participants 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 **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 and Johnson Orthopaedics, Bracknell, UK) • Randomised = unknown; losses = unknown; analysed for all outcomes = 39 **Intervention group 2** • HA Thompson, unipolar, cemented • Randomised = unknown; losses = unknown; analysed for all outcomes = 34

Calder 1995 *(Continued)*

	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:** pain and mobility (using Nottingham Health Profile; at 6 months)
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)	Unclear risk	Described as randomised, but no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. We could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	It is not reported whether participants were blinded to the intervention group; however, we did not expect this would influence outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	Number of randomised participants is not reported for the intervention groups in this study, but it is understood that only a few participants responded to the questionnaire and provided outcome data for this study.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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)

Calder 1996 *(Continued)*

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

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 one 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 and Johnson Orthopaedics, Bracknell, UK) • Randomised = 118; losses = 51 (37 died at 1 year; other losses are unexplained); analysed for pain and mobility = 56 (data available from an interim report with fewer participants); analysed for all other outcomes = 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 for pain and mobility = 72 (data available from an interim report with fewer participants); analysed for all other outcomes = 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

Calder 1996 *(Continued)*

	Outcomes relevant to the review: mortality (at 4 and 12 months); return to preoperative place of residence; no pain or mild pain; dislocation; deep infection; length of hospital stay; mobility and pain scores (Nottingham Health Profile) **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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. 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) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Not reported whether participants were blinded to the intervention; although unlikely that this would influence participants' decisions.
Blinding of outcome assessment (detection bias) objective outcomes	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	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 from an interim report for mobility and pain, which included fewer participants, and we could not be certain whether this data included attrition.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Cao 2017

Study characteristics

Methods	RCT; parallel design

Cao 2017 *(Continued)*

	Review comparison group: HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 85 **Inclusion criteria:** intertrochanteric fracture; ≥ 66 years old; normal walking without or with single stick before fracture; Evans-Jensen type III to V fracture complicated with many underlying diseases **Exclusion criteria:** new or old cerebral thrombosis or Evans-Jensen type I fracture; cardiac insufficiency; pathological fracture; complicated with coagulation disorders; mental diseases **Setting:** single centre; hospital; China **Baseline characteristics (overall)** • Age, "average" (range): 79.6 (66 to 98) years • Gender, M/F, n: 36/49 • Comorbidities, n: osteoporosis 85; coronary heart disease 35; hypertension 40; diabetes 18; chronic bronchitis and emphysema 14; hypoproteinaemia and anaemia 15; cerebral infarction 14; renal insufficiency 2 • Preoperative waiting time: ranged from 3 hours to 12 days; average 5.5 days • Fracture classification, Evans-Jensen classification, n: type II: 8; type III: 2; type IV: 22; type V: 13 **Note:** • study authors did not report: smoking history, medication, BMI, cognitive status, mobility assessment, place of residence
Interventions	**General details:** subarachnoid block combined epidural anaesthesia; post-lateral approach; prophylactic anticoagulation and antibiotics; DVT prevention; mobilisation within 3 days to 1 week postoperatively; partial weight-bearing after 3 weeks post-surgery; full weight-bearing after 3 months. Follow-up at 1, 3, 6 months and 1 year after the surgery **Intervention group 1** • HA cemented; "bone cement auxiliary ordinary biology stem of artificial hip joint replacement" • Randomised = 43; loss to follow-up not reported; analysed = 43 **Intervention group 2** • HA uncemented; "biological type lengthened handle artificial hip replacement" • Randomised = 42; loss to follow-up not reported; analysed = 42 **Note:** • We noted a discrepancy in the reported numbers of participants in the outcome tables for both groups in the study report. We used the numbers of participants as reported in the text.
Outcomes	**Outcomes measured/reported by study authors:** operation time; total blood loss; ambulation time; HHS (available at 1, 3, and 6 months); loosening; neurovascular injury; infection; fracture; dislocation; pain in non-femoral region; mortality **Outcomes relevant to the review:** HHS (3 months, 6 months); superficial and deep infection; fracture; loosening; dislocation; venous thromboembolic phenomena (neurovascular injury); intraoperative fracture **Note:** • final follow-up at "6 to 34 months after the surgery, with an average time of 24 months" • we did not include mortality data because they were reported for the overall group only
Notes	**Funding/sponsor/declarations of interest:** funding not reported. Study authors declare no conflicts of interest

Cao 2017 *(Continued)*

Study dates: January 2012 to January 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "random number table method"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	We assumed no losses. We noted a minor discrepancy in the number of reported participants in the study report between text and tables; we did not expect this to influence outcome data.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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 65–79 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

Chammout 2017 *(Continued)*

- 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
- 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 participants; 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; participants 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; losses = 2 (died); analysed for mortality, unplanned return to theatre = 35; analysed for HRQoL, HHS, ADL and pain at 3 months = 34; analysed for HHS and pain at 12 months = 34; analysed for ADL and HRQoL at 12 months = 33 **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; losses = 2 (died); analysed for mortality, unplanned return to theatre = 34; analysed for HRQoL = 30 (at 3 months); analysed for HHS (at 3 and 12 months) and ADL (at 3 months) = 31; analysed for ADL = 30; analysed for HRQoL and pain (at 12 months) = 29
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 infarction; cerebral vascular lesions; pulmonary embolism; DVT; heterotopic ossification at 24 months **Outcomes relevant to the review:** unplanned return to theatre, dislocation, intraoperative periprosthetic fracture, postoperative periprosthetic fracture, superficial infection, loosening of prosthesis (defined by study authors as unstable stem) (all reported at 24 months); mortality (at 12 months); HRQoL (using EQ-5D), functional status (using HHS), ADL, pain (using Pain Numerical Rating Score), (all functional outcomes reported at 3 and 12 months) **Notes:**

Chammout 2017 *(Continued)*

- Because of the manner of reporting, we could not attribute the following general complications reported to intervention groups: pulmonary embolisms, DVT, acute MI and heart failure.
- 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

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Block randomisation
Allocation concealment (selection bias)	Unclear risk	Use of sealed envelopes, but does not state whether envelopes were opaque or numbered
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	Participants were blind to allocation. It is not possible to blind surgeons to treatment groups. The surgeons in the study were experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Participants were blind to allocation.
Blinding of outcome assessment (detection bias) objective outcomes	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	Participant loss was mostly clearly reported, with few losses which were reasonably balanced between groups.
Selective reporting (reporting bias)	Unclear risk	Study authors reported a pre-published protocol and clinical trials registration (NCT02247791). The study commenced in 2009 but the clinical trial registration did not occur until 2013 and the protocol was published in 2016. We cannot feasibly assess the risk of reporting bias using these documents.
Other bias	Low risk	We identified no other sources of bias.

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; people with rheumatoid arthritis in the fractured hip; people 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 adverse events = 60; analysed for ADL, HHS, HRQoL and pain at 3 months = 57; analysed for ADL, HHS, HRQoL and pain at 12 months = 56 **Intervention group 2** • HA; cemented unipolar head replacement, CPT Zimmer

Chammout 2019 *(Continued)*

	• Randomised = 60; losses = 13 (4 died; 9 withdrew) analysed for mortality and adverse events = 60; analysed for ADL, HHS, HRQoL and pain at 3 months = 54; analysed for ADL, HHS, HRQoL and pain at 12 months = 50 **Note:** • 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 participants 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:** ADL (number of people who were fully independent in ADL; at 3 months and 12 months), functional status (using HHS; at 3 months and 12 months), HRQoL (using EQ-5D utility index - VAS not reported; at 3 months and 12 months), pain (using VAS; at 3 months and 12 months); adverse events (at 2 years): MI, pulmonary embolism, cerebrovascular accident, infection, acute kidney injury, dislocation, pneumonia; mortality (at 24 months); unplanned returned to theatre (2 years); discharged to geriatric ward **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) objective outcomes	Unclear risk	Particpants blinded but It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were performed or supervised by consultants but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Participants blinded to intervention
Blinding of outcome assessment (detection bias)	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data.

Chammout 2019 *(Continued)*
objective outcomes

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

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

Cornell 1998 *(Continued)*

	Intervention group 1 • Bipolar; cemented modular femoral component (Orthopaedic Devices Corporation, Allendale, USA) • Randomised = 33; losses = 2 (owing to death); analysed for all outcomes = 33 **Intervention group 2** • Unipolar; cemented modular femoral component (Orthopaedic Devices Corporation, Allendale, USA) • Randomised = 15; losses = 1 (owing to death); analysed for all outcomes = 15
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); functional status (Johansen hip rating questionnaire); mobility (Get Up and Go, in seconds; at 6 months); dislocation; length of stay **Notes:** • study follow-up at 6 months • we did not use the 6MWT data because we could not be certain how this test was conducted because the data were reported in seconds rather than metres • we did not report data for DVT because we could not be certain that this event was reported in both groups
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 did not state whether envelopes were opaque and sequentially numbered and we have therefore judged that there is insufficient information
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	Participants blinded. It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	Low risk	Assessments for functional outcomes/mobility completed by a physical therapist blinded to allocation
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect that lack of blinding would influence participant-reported outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data.

Cornell 1998 *(Continued)*

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

Davison 2001

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar (versus internal fixation) **Note:** • study has 3 arms. In this review, we have not included data for participants who were randomised to a hip screw because these participants were not eligible for inclusion in the review.

Participants	**Total number of randomised participants:** 187
	
	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, 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, median (IQR): 2 (1 to 3) days
	
	Note:

Davison 2001 *(Continued)*

- 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 for mortality, unplanned return to theatre, adverse events = 97; analysed for HHS at 12 months = 85; analysed for HHS at 5 years = not reported **Intervention group 2** • HA unipolar; cemented Thompson HA • Randomised = 90; losses = 25 (owing to death); analysed for mortality, unplanned return to theatre, adverse events = 90; analysed for HHS at 12 months = 80; analysed for HHS at 5 years = not reported
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); complications (infection and dislocation - up to 5 years); unplanned return to theatre; HHS (12 months and 5 years), Barthel Index **Notes:** • Barthel Index not reported in sufficient detail to be included in analysis (reported only as P value). • 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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.

Davison 2001 *(Continued)*

Blinding of outcome assessment (detection bias) objective outcomes	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	Participant loss was because of death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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

DeAngelis 2012 *(Continued)*

- 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
- 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 participants received a unipolar head; all participants 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 for mortality, postoperative complications and discharge destination = 66; analysed for ADL at 60 days = 58; analysed for ADL at 12 months = 54

Intervention group 2

- HA uncemented; femoral prosthesis (VerSys Beaded FullCoat; Zimmer, Warsaw), unipolar
- Randomised = 64; losses at 12 months = 10 (owing to death); analysed for mortality, postoperative complications destination = 6; analysed for ADL at 60 days = 59; analysed for ADL at 12 months = 54

Notes:

- unplanned return to theatre: reasons for re-operation not reported; types of re-operation were not reported

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.

DeAngelis 2012 *(Continued)*

	Outcomes relevant to the review: mortality (at 60 days, and 1 year); functional: IADL (at 60 days and 1 year); acute postoperative complications (pneumonia, MI, wound infection, CVA, thromboembolic event, re-operation); intraoperative fracture; blood transfusion; discharge destination (assisted living, rehabilitation facility, home) **Notes:** • study authors do not describe wound infection as either superficial or deep. We have categorised these data as superficial infection in the analysis • we noted some missing data for discharge destination, and we have therefore added a category in the analysis for unknown destination
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
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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. 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) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Loss of participants is unknown. We attempted to contact study authors to clarify numbers of participants who died, and numbers of participants available for ADL data. For complications data and discharge destination, data appear to be complete
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.
Other bias	Low risk	We identified no other sources of bias.

Dorr 1986

Study characteristics

Dorr 1986 *(Continued)*

Methods	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
	• 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

Dorr 1986 *(Continued)*

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 for all outcomes = 39 **Intervention group 2** • HA cemented, bipolar; the ball size was matched anatomically • Randomised = 37; losses not reported; analysed for all outcomes = 37 **Intervention group 3** • HA uncemented, bipolar; the ball size was matched anatomically • Randomised = 13; losses not reported; analysed for all outcomes = 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; reoperation; dislocation; modified d'Aubigne and Postel hip score (D'Aubigne 1954); heterotopic ossification; progressive femoral and acetabular cement-bone demarcatlon; 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; not walking at final follow-up (between 2 and 4 years); infections (between 2 and 4 years); re-operation and dislocations (between 2 and 4 years); pain and ambulation (using 6 point scale in which high scores indicate less pain/better mobility; at 3 and 24 months) **Notes:** • we did not report data for mortality because they were 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
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)	Unclear risk	It is not possible to blind surgeons to treatment groups. 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.

Dorr 1986 *(Continued)*

objective outcomes		
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect that lack of blinding of participant-reported outcomes would influence outcome data.
Blinding of outcome assessment (detection bias) objective outcomes	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	Unclear risk	We could not be certain whether data were complete because numbers of losses were not reported.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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 at 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 at alone/with family/sheltered accommodation, n: 12/10/4 • Fracture classification, n: 100% displaced

Emery 1991 *(Continued)*

	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; participants 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 for mortality, infection, pulmonary embolism = 27; analysed for length of stay = 25; analysed for pain, pneumonia = 19 **Intervention group 2** • HA uncemented; Moore stem (bipolar), Monk duoplet design (Johnson & Johnson, England) • Randomised = 26; losses = 6 (owing to death); analysed for mortality, infection, pulmonary embolism = 26; analysed for length of stay = 24; analysed for pain, pneumonia = 20 **Note:** • 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); pain (measured as presence of any pain; at 17 months); increased dependency on walking aids; wound infection; chest infection; pulmonary embolism; length of stay (excluding those who died before hospital discharge) **Notes:** • follow-up at 17 and 18 months for cemented and uncemented groups respectively • not clearly reported whether infection is superficial or deep. We have categorised data as superficial infection in analysis.
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 a Moore stem, or a cemented prosthesis with a Thompson stem" Comment: study authors do not report method used to ensure that cards are randomised

Emery 1991 *(Continued)*

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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were performed by all junior staff, we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding of participant-reported outcomes to influence outcome data.
Blinding of outcome assessment (detection bias) objective outcomes	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	Participant loss was because of death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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 people, 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

Fernandez 2022 *(Continued)*

- 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
- 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
- Pre-operative 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
- Pre-operative waiting time, delay < 36 hours, n: 472

Fernandez 2022 *(Continued)*

- 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 will be 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 • Randomised = 610; losses due to death, withdrawn, and missing data (numbers not clearly presented); analysed at 4 months for: ADL and mobility = 366; pain = 360; HRQoL = 436; analysed at 12 months for: mortality = 610; ADL and pain = 300; HRQoL = 437; mobility = 302 **Intervention group 2** • HA uncemented; modern; including 187 bipolar and 411 unipolar; 593 HA coated; 62% general anaesthesia; 25% uncollared • Randomised = 615; losses due to death, withdrawn, and missing data (numbers not clearly presented); analysed at 4 months for: ADL = 349; pain = 345; HRQoL = 441; mobility = 349; analysed at 12 months for: ADL = 280; pain = 279; HRQoL = 438; mobility = 281 **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); ADL ('usual activities'; using 5-point Likert scale from EQ-5D; at 4 and 12 months); pain (using 5-point Likert scale from EQ-5D; at 4 and 12 months); discharge destination; mobility (mobile/no aids/one aid/two aids/indoor only/none; 4 and 12 months); adverse events: dislocation; DVT; cerebrovascular injury; wound infection; pneumonia; UTI; MI; blood transfusion; acute kidney injury; pulmonary embolism; periprosthetic fracture; unplanned return to theatre Note: • Wound infections were not described as 'superficial' or 'deep' infections; we included the data with data from other studies as 'superficial infections'.
Notes	**Funding/sponsor/declarations of interest:** National Institute for Health Research, Research for Patient Benefit **Study dates:** March 2017 to December 2019

Risk of bias

Fernandez 2022 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated by CTU
Allocation concealment (selection bias)	Low risk	Allocation concealed due to randomisation being performed by the statistician from the CTU
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. We could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Participants blind to intervention
Blinding of outcome assessment (detection bias) objective outcomes	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	High risk	We noted a large number of losses for participant-reported outcomes at 12 months. These losses were mostly owing to death, but some were because of missing data and owing to withdrawn participants.
Selective reporting (reporting bias)	Low risk	Prospectively registered with clinical trials register (ISRCTN18393176; first received March 2017). Outcome data supplied by study authors are consistent with outcomes in the clinical trials register.
Other bias	Low risk	We identified no other sources of bias.

Figved 2009

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** HA: cemented versus uncemented
Participants	**Total number of randomised participants:** 230 fractures (223 participants; 7 participants 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

Figved 2009 *(Continued)*

- 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
- 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; 11 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 participants 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: length of stay = 109; blood transfusion = 111; mortality = 108; adverse events = 112; EQ-5D at 12 months = 61; functional status (HHS) at 12 months = 90; ADL (Barthel Index), need for pain medication at 3 months = 100; need for pain medication, and able to walk independently (at 12 months) = 91 ; discharge destination= 109; 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: length of stay, blood transfusion, discharge destination = 106; mortality = 105; need for pain medication at 3 months = 90; adverse events = 108; EQ-5D at 12 months = 60; ADL (Barthel Index) and functional status (HHS) at 12 months, need for pain medication, and able to walk independently (at 12 months) = 77; discharge destination = 106; 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; perioperative MI leading to death; intraoperative cardiac arrest

Figved 2009 *(Continued)*

	Outcomes relevant to the review: blood transfusions; length of stay in hospital; mortality (3, 12 months, 5 years); HHS (3, 12 months, 5 years); ADL (participants with Barthel Index of 19 or 20; at 3, 12 months, 5 years); EQ-5D (we have used data from the VAS in analysis; index score also available; at 3 months, 12 months, 5 years); living in own home (at discharge); no pain medication (3 months, 12 months, 5 years); walking independently (3 and 12 months); unplanned return to theatre (12 months); intraoperative fracture; loosening of prosthesis; MI; pneumonia; dislocation; DVT; superficial infection; pulmonary embolism; deep infection; intraoperative periprosthetic fracture; postoperative periprosthetic fracture; postoperative MI not leading to death and perioperative MI leading to death **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 **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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. 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) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Collected with assistance of research nurses who were blind to intervention
Blinding of outcome assessment (detection bias) objective outcomes	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	Participant loss was because of death or otherwise clearly reported
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.
Other bias	Low risk	We identified no other sources of bias.

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 **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; and functional status = 10 **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 and functional status = 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)

Figved 2018 *(Continued)*

	Outcomes relevant to the review: functional status (HHS; at 12 months) 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 were 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 **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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were performed by all experienced surgeons but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Uncertain whether participants were blind of the intervention, but unlikely to effect their decisions on HHS or EQ-5D
Blinding of outcome assessment (detection bias) objective outcomes	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	Reasons for attrition are clearly reported in CONSORT diagram; losses are few and are balanced between groups
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.
Other bias	Low risk	We identified no other sources of bias.

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
	• 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 OHS and EQ-5D at 4 months = 7; analysed for OHS and EQ-5D at 12 months = 9 **Intervention group 2**

Griffin 2016 *(Continued)*

- 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 OHS and 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:** dislocation; EQ-5D and OHS (4 months and 12 months); mortality (12 months); re-operation **Notes:** • we contacted study authors, who provided data for EQ-5D and OHS 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) objective outcomes	Unclear risk	Participants and research associates, but not the operating surgeon, were blinded to the allocation of treatment. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Participants were blind to the intervention.
Blinding of outcome assessment (detection bias) objective outcomes	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	Loss to follow-up is clearly reported.
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.
Other bias	Low risk	We identified no other sources of bias.

Harper 1994

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 to 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 for mortality, dislocations, and infections = 71 **Intervention group 2** • HA uncemented; Thompson (unipolar); the femoral cavity was only partially reamed; polymethylmethacrylate cement was inserted by a finger-packing technique • Randomised = 66; 2 died during hospital stay; analysed for length of hospital stay = 64; analysed for mortality, dislocations, and infections = 66
Outcomes	**Outcomes measured/reported by study authors:** dislocation; mortality; superficial and deep infection; length of stay in hospital; pain **Outcomes relevant to the review:** dislocation (at 2 months); mortality (3 and 12 months); dislocations (2 month), superficial and deep infection (2 months); length of stay in hospital; pain (3 months)
Notes	**Funding/sponsor/declarations of interest:** not reported

Harper 1994 *(Continued)*

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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) 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.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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; 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

HEALTH 2019 *(Continued)*

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. people with no fixed address, report a plan to move out of town, alcohol abuse issues or intellectually-challenged people 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

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:

HEALTH 2019 *(Continued)*

- 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; 31 lost from initial allocation, due to improper consent (13), unauthorised surgeon (1), withdrawal prior to surgery (6), ineligibility (11); a further 190 lost before 2-year follow-up, due to death (103), unable to locate (38), consent withdrawn (41), improper randomisation (1), site closed (5), cross-over (1), other surgeon involved (1); 528 completed follow-up (2 years); analysed for HRQoL at 24 months = 433

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, 23 lost from initial allocation, due to improper consent (11), withdrawal prior to surgery (3), ineligibility (9); a further 193 lost before 2-year follow-up, due to death (95), unable to locate (39), consent withdrawn (55), improper randomisation (1), site closed (3); 530 completed follow-up (2 years); analysed for HRQoL at 24 months = 411

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); periprosthetic fracture; dislocation; deep and superficial infection; loosening; discharge destination; functional status (WOMAC); pain (WOMAC); mobility (TUG); HRQoL (EQ-5D; at 24 months)

Notes:

- mean and SD provided by authors for function, HRQoL and mobility outcomes (via email communication)
- study authors reported HRQoL using two measurement tools (SF-12 and EQ-5D). We used data using EQ-5D because these were measured by more of the studies in this comparison group. Similarly for functional status, data were reported using WOMAC and TUG, and we used data from the WOMAC tool because these were measured more frequently.
- 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

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation with minimisation
Allocation concealment (selection bias)	Low risk	Quote: "centralised 24 h computerised randomisation system that will allow internet-based randomisation"
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors describe the experience level of surgeons in each group, and we noted these were evenly balanced. However, it is unclear if each surgeon was equally experienced with both types of implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias)	Low risk	We did not expect that lack of blinding for participant-reported outcomes would influence outcome data.

HEALTH 2019 *(Continued)*

participant-reported outcomes		
Blinding of outcome assessment (detection bias) objective outcomes	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	High risk	Substantial numbers of participants lost to follow-up and reported as "unable to locate" and "withdrew consent"
Selective reporting (reporting bias)	Low risk	Protocol published and prospectively registered with a clinical trials register (NCT00556842; first received November 2007). Outcomes reported in the published report are consistent with those in the prospectively published documents.
Other bias	Low risk	We identified no other sources of bias

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; people 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
	• 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

Hedbeck 2011 *(Continued)*

- 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 **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
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), ADL Katz index A or B (at 12 months); unplanned return to theatre (at 12 months); adverse events: dislocation, deep infection, periprosthetic fracture; pneumonia; cardiac complication, DVT, pulmonary embolism (all at 12 months); function and pain (HHS; at 4 months and 12 months)
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

Hedbeck 2011 *(Continued)*

Allocation concealment (selection bias)	Low risk	Quote: "opaque sealed-envelope technique, independently prepared"
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeons in the study were experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	Outcomes assessed by a nurse independent to the surgical team; however, the "research nurse was not blinded to the type of surgical intervention"
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Not reported whether participants were blind to intervention, although unlikely to effect outcomes
Blinding of outcome assessment (detection bias) objective outcomes	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.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Inngul 2015

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA & HA: cemented versus uncemented • Participants aged between 65 and 79 years were allocated to treatment with either a cemented THA or a reverse hybrid THA. • Participants 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:** people 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)

Inngul 2015 *(Continued)*

- 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:

- 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-weight 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; no losses reported for mortality and adverse events; losses at 24 and 48 months for function outcomes but only pain data agreed with numbers from flow chart

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; no losses reported for mortality and adverse events; losses at 24 and 48 months for function outcomes but only pain data agreed with numbers from flow chart

Outcomes

Outcomes measured/reported by study authors: HRQoL questionnaire (EQ-5D); SMFA; HHS; bleeding and operating time; adverse events; post-operative 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: adverse events (at 12 months): intraoperative periprosthetic fracture (intra-operative femoral fracture); unplanned return to theatre (for dislocation, periprosthetic fracture and for deep infection); superficial wound infection; UTI; pneumonia; acute MI; acute renal failure; mortality (4 and 12 months); HRQoL (EQ-5D), functional status (HHS); pain using HHS (24 and 48 months)

Notes:

- we have used data at 4 and 12 months. Study authors also reported data at 24 and 48 months.

Inngul 2015 *(Continued)*

- for intraoperative periprosthetic fracture, we included only data described as intraoperative femoral fracture. Data were also available for intraoperative fracture of the tip of the greater trochanter.
- HRQoL data were reported in a figure and we could not confidently extract numerical data for the review. In addition, data for HHS were reported without numbers of participants in each group and did not match flow chart numbers for 24 and 48 months.
- 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

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not reported
Allocation concealment (selection bias)	Low risk	Quote: "patients were randomised using sealed, numbered, opaque envelopes"
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeons in the study were experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	High risk	Some losses owing to death, which is expected in this population. However, we noted some participant loss which was not explained.
Selective reporting (reporting bias)	Unclear risk	Retrospectively registered with a clinical trials register (NCT01798472; first received February 2013). It is not feasible to assess risk of selective reporting bias because study was registered at the end of the study period.
Other bias	Low risk	We identified no other sources of bias.

Iorio 2019

Study characteristics

Methods	Quasi-RCT; parallel design

Iorio 2019 *(Continued)*

	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; people > 60 years of age; able to walk unaided before fracture **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); dislocation, re-operation, length of stay (all at 12 months) **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

Iorio 2019 *(Continued)*

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"
Allocation concealment (selection bias)	High risk	Not possible to conceal an alternate allocation method
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) 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.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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

Jeffcote 2010 *(Continued)*

- WOMAC, mean: 88

Intervention group 2 (unipolar)

- 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 participants (25 hips); analysed for mortality and deep infection = 24 **Intervention group 2** • HA unipolar; Unitrax head • Randomised = 27; analysed for mortality and deep infection = 27 **Notes:** • 10 participants withdrew (unclear how these are 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); functional status (using HHS and WOMAC) and 6MWT; deep infection **Notes:** • we did not report HHS, 6MWT and WOMAC because these data were reported in a figure from which we could not confidently extract numerical data • 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

Jeffcote 2010 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Although participants may have been aware of the type of intervention used, we did not expect that this knowledge would influence their assessments of hip function.
Blinding of outcome assessment (detection bias) objective outcomes	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	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 unclearly reported. We included only data for mortality which were complete.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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 not intact; 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, %:

Kanto 2014 *(Continued)*

- 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
- 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 performing the operations, senior consultants 27%, 73% orthopaedic residents; spinal anaesthesia; preoperative prophylactic cefuroxime, or clindamycin in case of cefuroxime allergy, was infused 30 min prior to surgery; low-molecular-weight mini-heparin starting at 6 hours preoperatively and continuing for 4 weeks postoperatively except those with permanent preoperative warfarin treatment when mini-heparin was given until the international normalisation ratio (INR) had been between 2 and 3 for 2 days; participants 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 for all outcomes = 87

Intervention group 2

- HA unipolar; heads were available in sizes from 38 mm to 60 mm

Kanto 2014 *(Continued)*

- Randomised = 88; analysed for for all outcomes = 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 • 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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were performed by all 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) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) 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.
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.
Other bias	Low risk	We identified no other sources of bias.

Keating 2006

Study characteristics

Keating 2006 *(Continued)*

Methods	RCT; parallel design **Review comparison group:** THA versus HA **Note:** • study included 2 separate comparison groups: HA vs internal fixation and a 3-arm comparison (HA vs internal fixation vs THA). Study authors did not explain why participants were randomised to the 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 review.
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 **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 mortality and complications = 69; analysed for other outcomes = 66 **Intervention group 2** • HA bipolar, cemented hemiarthroplasty • Randomised = 111; 107 received HA, 4 other; reported as ITT; analysed for mortality and complications = 111; analysed for other outcomes = 102
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 infec-

Keating 2006 *(Continued)*

	tion, septicaemia, deep venous thrombosis, pulmonary embolism, stroke, and MI; blood transfusion; discharge destination; length of stay **Outcomes relevant to the review:** hip-rating questionnaire: pain and function at 4 and 12 months reported; HRQoL using EQ-5D (utility index score, no VAS reported) at 4 and 12 months; mortality (at 4 months and 24 months), re-operation, dislocation, infection, DVT, pulmonary embolism, MI, blood transfusion all at 24 months; discharged to own home; length of stay **Notes:** • data taken from total recruited for HA rather than smaller subgroup used in the analysis in the paper • infection described as "wound infection", assumed to be superficial • 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 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) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeons in the study were competent to undertake the allocated procedure and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Not certain whether participants were blind to intervention, but low risk of bias as it is unlikely to effect outcomes
Blinding of outcome assessment (detection bias) objective outcomes	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)	Low risk	Participant loss was not explained, but ITT analysis was used, and we noted few losses in both groups.

Keating 2006 *(Continued)*
All outcomes

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

Kim 2012

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA: short stem versus conventional stem
Participants	**Total number of randomised participants:** 161 participants/hips **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 post-operative 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 • Randomised = 81; losses = 11 (5 lost to follow-up at 24 months, 6 died within 1 year); analysed for mortality = 81; analysed for other outcomes = 70 **Intervention group 2**

Kim 2012 *(Continued)*

- THA, anatomical medullary locking fully porous coated cementless femoral component (DePuy, Warsaw, Indiana) with the 36 mm Biolox delta ceramic modular head
- Randomised = 80; losses = 10 (5 lost to follow-up at 24 months, 5 died within 1 year); analysed for mortality = 80; analysed for other outcomes = 70

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; fracture; dislocation; superficial infection; pain; walking ability **Outcomes relevant to the review:** functional status (HHS); thigh pain (number of people experiencing thigh pain); UTI; acute kidney injury; pneumonia; mortality; fracture; dislocation; superficial infection (at 24 months) **Notes:** • we did not report data for mental status change because they were not described adequately • functional status was reported using 2 measurement tools (HHS and WOMAC). In the review, we included data using HHS.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** November 2006 and November 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The patients were randomly assigned, by means of a computer-generated random number table"
Allocation concealment (selection bias)	Low risk	Quote: "randomisation table was stored at the co-ordinating centre"
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeons in the study were experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	Low risk	Assessed by nurse separate from surgical team but we judged that this nurse was unaware of the types of interventions
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Unclear whether participants were blind to intervention, but unlikely that this would bias participant reported outcomes
Blinding of outcome assessment (detection bias) objective outcomes	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	We noted that participant loss was because of death and because of loss to follow-up. These losses were balanced between groups and therefore we did not expect losses to introduce attrition bias.

Kim 2012 *(Continued)*

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

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 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 **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 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 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 mm to 119 mm

Lim 2020 *(Continued)*

- Randomised = 77 hips; initial follow-up (1 year) 7 lost or refused, 12 died; final follow-up (2 years) a further 14 lost or refused, 4 died; analysed for mortality = 77

Intervention group 2

- HA standard; Bencox ID stem (Corentec, Cheonan-si, South Korea); proximal Ti-plasma spray porous-coated standard metaphyseal fixation; length 137 mm to 177 mm
- Randomised = 74 hips; initial follow-up (1 year) 6 lost or refused, 14 died; final follow-up (2 years) a further 13 lost or refused, 6 died; analysed for mortality = 74

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; superficial Infection at 12 months; pain (without/with); mobility (outdoors/housebound) **Notes:** • mean follow-up period was 24.7 ± 16.5 months in Group A and 22.0 ± 3.1 months in group B
Notes	**Funding/sponsor/declarations of interest:** study authors received no funding and declared no conflicts of interest **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Used software to generate random numbers
Allocation concealment (selection bias)	Low risk	Allocation completed by independent statistician
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding for participant-reported outcomes to influence outcome data.
Blinding of outcome assessment (detection bias) objective outcomes	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	High risk	High proportion of loss to follow-up; described only as lost or refused

Lim 2020 *(Continued)*

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

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 for all outcomes = 48 **Intervention group 2** • HA uncemented; press-fit Moore-bipolar (DePuy-Thackray) • Randomised = 34; analysed for all outcomes =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)

Livesley 1993 *(Continued)*

Outcomes relevant to the review: mortality (at 30 days, and 1 year); functional assessment (using a 5-point scale across 9 domains by Benjamin 1990; higher scores indicate better function); discharge destination; adverse events: perioperative fractures, dislocation, infection, revision

Notes:

- function data are reported without mean and SD
- we did not include data for discharge destination because study authors only reported discharge to an orthogeriatric unit and did not report how many were discharged to their own home by group
- we included data for calcar splits as 'periprosthetic fracture'; data were also available for shaft fracture, greater trochanteric detachment, lesser trochanter detachment and we tested this decision in sensitivity analysis
- 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) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) 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. Data for all outcomes were complete.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Macaulay 2008

Study characteristics

Macaulay 2008 *(Continued)*

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

Participants	**Total number of randomised participants:** 41
	
	Inclusion criteria: > 50 years of age; independent ambulation before fracture; displaced femoral neck fracture (Garden 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:
	  ○ Caucasian (understood to be 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:
	  ○ Caucasian (understood to be 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; losses = 1 (withdrew after surgery); analysed for all outcomes = 17 **Intervention group 2** • HA; surgeon's preference for cemented/uncemented and unipolar/ bipolar prosthesis • Randomised = 23; analysed for all outcomes = 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:** length of stay in hospital, mortality (at 6 months, and 34 months); dislocation, MI, pneumonia, UTI, wound infections (at 6 months); SF-36 (physical components), WOMAC (pain), functional status (HHS), mobility (TUG) (all at 12 months)

Macaulay 2008 *(Continued)*

	Notes: • data for WOMAC, HRQoL, HHS, and TUG used ITT analysis • type of wound infection is not specified. We have included these data as 'superficial infections'.
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

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Each site had an individual blocked randomization scheme, which was verified at the coordinating site for compliance. "
Allocation concealment (selection bias)	Low risk	Quote: "opaque sealed-envelope technique"
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Although participants may have been aware of the type of intervention used, we did not expect that this would influence their assessments of relevant outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	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	Data complete for all outcomes
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Malhotra 1995

Study characteristics

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

Malhotra 1995 *(Continued)*

Participants	**Total number of randomised participants:** 68 **Inclusion criteria:** elderly people with femoral neck fractures **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 anti-coagulation 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; analysed for all outcomes = 32 **Intervention group 2** • HA unipolar, Austin-Moore • Randomised = 36; analysed for all outcomes = 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:** dislocation (first week); deep infection (two year follow-up); length of hospital stay; functional status (using Devas 1983; categorical data as excellent, good, fair, and unsatisfactory; at 12 months) **Notes:** • study authors aimed to collect, but did not report, outcome data for loosening
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** commenced January 1989; 4 year period

Risk of bias

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

Malhotra 1995 *(Continued)*

Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No participant loss reported, and we could not be certain whether the study included participants who died during study follow-up
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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 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:

Moerman 2017 *(Continued)*

- 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 therapy; 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 • Randomised = 110; reported losses = 57 (21 died at 12 months; 36 lost to follow-up); analysed for ADL at 3 months = 62; ADL at 12 months = 53; HRQoL at 3 months = 54; HRQoL, mobility at 12 months = 50; mobility at 12 months = 41; pain at 3 months = 61; pain at 12 months = 51; mortality, unplanned return to theatre, length of hospital stay, adverse events = 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 ADL at 3 months = 52; ADL at 12 months, pain at 12 months = 43; HRQoL at 3 months = 48; HRQoL at 12 months = 40; mobility at 3 months = 38; mobility at 12 months = 33; pain at 3 months = 55; mortality, unplanned return to theatre, length of hospital stay, adverse events = 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); MI; venous thromboembolic phenomena (pulmonary embolus, DVT); acute renal failure; CVA (stroke/TIA); urinary tract infection; infection leading to revision; periprosthetic fracture (intra- and postoperatively); dislocation; superficial wound infection (all complications at 1 year); mobility (9-point mobility scale; 12 weeks and at 1 year); ADL (GARS; at 12 weeks and 1 year); HRQoL: SF-12 (physical component; at 12 weeks and 1 year); mid-thigh pain; length of hospital stay; blood transfusion **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

Moerman 2017 *(Continued)*

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) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. 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) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Participants blind to intervention
Blinding of outcome assessment (detection bias) objective outcomes	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	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.
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.
Other bias	Low risk	We identified no other sources of bias.

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)

Moroni 2002 *(Continued)*

- 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) **Outcomes relevant to the review:** mortality; functional status (HHS); HRQoL (SF-36); dislocation **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.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. 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.

Moroni 2002 *(Continued)*

Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect that lack of blinding for participant-reported outcomes would influence outcome data.
Blinding of outcome assessment (detection bias) objective outcomes	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	Unclear risk	Study authors did not report whether there were any losses, and because of other limited details in the abstract, we could not be certain whether data were complete.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	High risk	Published only as an abstract with limited detail on study characteristics. In addition, we expected the abstract publication was not peer-reviewed and we judged this to increase risks of other bias.

Mouzopoulos 2008

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA versus HA **Note:** • study includes a third intervention arm (internal fixation) which we did not include in the review
Participants	**Total number of randomised participants:** 86 **Inclusion criteria:** displaced subcapital hip fracture (Garden 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

Mouzopoulos 2008 *(Continued)*

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

Note:

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

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; losses at 12 months = 10 (2 had previous hip fracture; 6 died; 2 data lost); losses at 4 years = 10 (9 died between 12 months and 4 years; 1 revised); analysed for mortality, unplanned return to theatre and length of stay = 43; analysed for ADL and HHS at 12 months = 33; analysed for ADL and HHS at 4 years = 23 **Intervention group 2** • HA; Merete (Berlin, Germany) • Randomised = 43; losses at 12 months = 13 (5 had previous hip fracture; 6 died; 2 revised); losses at 4 years = 10 (7 died between 12 months and 4 years; 3 revised); analysed for mortality, unplanned return to theatre and length of stay = 43; analysed for ADL and HHS at 12 months = 30; analysed for ADL and HHS at 4 years = 20 **Note:** • study authors did not report the following intervention details: skills and experience of surgeons, type of anaesthesia, use of prophylactic antibiotics or anti-thromboembolics, 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:** ADL (BI; scores 0 to 100; higher scores indicate more independence; at 12 months and 4 years); functional status (HHS, mean scores; at 12 months and 4 years); mortality (at 12 months and 4 years); length of hospital stay; 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

Risk of bias

Bias	Authors' judgement	Support for judgement

Mouzopoulos 2008 *(Continued)*

Random sequence generation (selection bias)	High risk	Two levels of randomisation; every third participant is selected to be included in the study, and then participants are "randomly divided" into groups by two orthopaedic surgeons. We believed the first level of randomisation indicated the potential to manipulate the order of participants included in the study.
Allocation concealment (selection bias)	High risk	Not described. Because the initial methods selected participants according to order, we judged there to be no allocation concealment.
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were performed by all orthopaedic surgeons but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect that lack of blinding for participant-reported outcomes would influence outcome data.
Blinding of outcome assessment (detection bias) objective outcomes	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	Some losses are owing to death, which is expected in this population with a long study follow-up. Other losses were explained and relatively balanced between groups.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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 **Setting:** hospital; single centre; Slovenia **Baseline characteristics**

Movrin 2020 *(Continued)*

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 participants; 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 for pain = 55; analysed for adverse event = 79; analysed for HHS at 6 weeks = 72; analysed for HHS at 24 months = 45 **Intervention group 2** • HA uncemented modular bipolar • Randomised = 79; losses = 27 (owing to death at 24 months); analysed for pain = 52; analysed for adverse event = 79; analysed for HHS at 6 weeks = 76; analysed for HHS at 24 months = 49
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:** pain (6 months); fracture (intraoperative and postoperative); dislocation; deep infection; mortality (7 days and 24 months); functional status (HHS; 6 weeks and 24 months) **Note:** • we did not report data for revision surgery because it was unclear if these data were reported for all participants and for both 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) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeons in the study were experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Participants blinded to intervention
Blinding of outcome assessment (detection bias) objective outcomes	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	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.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Parker 2010c

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, > 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

Parker 2010c *(Continued)*

	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 Hardinge 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 for: pain at 3 months = 164; pain at 12 months = 141; pain at 5 years = 26; mobility at 5 years = 29; analysed for all other outcomes = 200 **Intervention group 2** • HA uncemented; Austin-Moore (Stryker/Howmedica Ltd, Newbury, UK) • Randomised = 200; losses = 119 (died by end of follow-up); analysed for: pain at 3 months = 160; pain at 12 months = 131; pain at 5 years = 32; mobility at 5 years = 34; analysed for all other outcomes = 200 **Note:** • study authors did not report the following intervention details: type of anaesthesia
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:** operative fracture; length of stay in hospital; pneumonia; DVT; pulmonary embolism; CVA; acute renal failure; MI; superficial and deep infection; dislocation; revision;

Parker 2010c *(Continued)*

	postoperative fracture requiring revision; blood transfusion; delirium (acute confusional state); pain (at 3 months, 12 months, and 5 years); mobility (at 12 months, and 5 years); mortality (at 2 to 3 months, 12 months and 5 years); return to original residence **Note:** • 12-month mortality data and SDs for mobility data provided by study author; data for early mortality taken from previous version of the review (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) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeon in the study was experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding for participant-reported outcomes to influence outcome data.
Blinding of outcome assessment (detection bias) objective outcomes	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	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.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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; declined to participate; senile dementia; significant arthritis of the hip to be treated with THA; fractures treated by internal fixation; people 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 participant in the lateral position; all participants 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) • Randomised = 100; losses = 36 (died at 1 year); analysed for pain and mobility = 75; analysed for other outcomes = 100 **Intervention group 2** • HA cemented Thompson prosthesis (Corin Surgical Ltd) • Randomised = 100; losses = 25 (died at 1 year); analysed for pain and mobility = 75; analysed for other outcomes = 100 **Note:**

Parker 2012 *(Continued)*

	• 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); length of hospital stay; blood transfusion; superficial infection; deep infection; dislocation; periprosthetic fracture (operative fracture femur); complications (pneumonia, DVT, pulmonary embolism, CVA, cardiac failure, delirium; acute renal failure); pain (mean scores); mobility (change in mean scores; at 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

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: "randomised by the opening of a sealed opaque numbered envelope"
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeon in the study was experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	Low risk	Quote: "all assessments were made by a nurse who was blinded to the treatment allocation"
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding for participant-reported outcomes to influence outcome data.
Blinding of outcome assessment (detection bias) objective outcomes	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	All losses were owing to death, which is expected in this population. No participant was lost to follow-up.

Parker 2012 *(Continued)*

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

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)
	
	• 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

Parker 2019 *(Continued)*

Intervention group 1

- THA; 29 were a CPCS stem (Smith and 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 for all outcomes = 52

Intervention group 2

- HA; 22 were monoblock Exeter Trauma Stems (Smith and 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 for all outcomes = 51

Note:

- study authors do not report number of clinicians or their experience, use of prophylactic antibiotics or anti-thromboembolics, 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; blood transfusion; superficial wound infection; deep wound infection; DVT; CVA; length of hospital stay; delirium; ADL (social dependency scale; 3 months and 12 months); mobility (3 months and 12 months); pain (3 months and 12 months)

Note:

- data for pain, mobility and social dependency from direct communication with study author
- 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
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) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeon in the study was experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias)	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.

Parker 2019 *(Continued)*

clinically-assessed subjective outcomes		
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Unclear whether participants were blind to intervention but unlikely to effect results. Study authors reported that a research nurse who was blinded to the treatment allocation measured function and pain outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	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	Participant loss was because of death, which is expected in this population. Study authors reported that no participant was lost to follow-up.
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.
Other bias	Low risk	We identified no other sources of 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) • 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

Parker 2020 *(Continued)*

- 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 for: ADL and pain at 3 months = 164; ADL and pain at 12 months = 146; mobility at 12 months = 147; for all other outcomes = 200 **Intervention group 2** • HA uncemented; fully hydroxyapatite-coated Furlong (JRI Orthopaedics, Sheffield, UK) • Randomised = 200; losses = 64 (died at 12 months); analysed for: ADL at 3 months = 165; pain at 3 months = 160; ADL at 12 months = 136; mobility at 12 months = 135; pain at 12 months = 134; for all other outcomes = 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:** blood transfusion; length of hospital stay; mortality (4 and 12 months); complications (pneumonia, MI, DVT, pulmonary embolism, delirium, CVA, acute renal failure); pain (at 3 months and 12 months); mobility (at 3 months and 12 months); ADL (social dependency; at 3 months 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)

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"

Parker 2020 *(Continued)*

Allocation concealment (selection bias)	Low risk	Quote: "sealed, identical, opaque envelopes "
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeon in the study was experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding to influence participant-reported outcomes. Function and pain measured by a research nurse who was blinded to the treatment allocation
Blinding of outcome assessment (detection bias) objective outcomes	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.
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.
Other bias	Low risk	We identified no other sources of bias.

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 (Gardens III or IV) **Exclusion criteria:** not reported **Setting:** single centre; hospital; location not reported **Baseline characteristics not reported** **Note:** • study authors reported no baseline details and we could not be certain whether prognostic factors were comparable between groups

Patel 2008 *(Continued)*

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 anti-thromboembolics, 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; length of hospital stay; deep infection; periprosthetic fracture; pain **Note:** • median follow-up time was 13 months • we did not include data for deep infection and periprosthetic fracture because we were not certain whether these were measured in both groups. We did not include data for pain because the scale used to report pain was not described and was reported using different reference points in each group (i.e. number experiencing mild pain in the bipolar group, and number complaining of pain in the unipolar group)
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 available detail

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) objective outcomes	Unclear risk	It is not possible to blind surgeons to types of interventions. 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) objective outcomes	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
Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trials registration or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
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.

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) **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/F, n: 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. • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
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**

Raia 2003 *(Continued)*

- 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, blood transfusion, dislocations = 55; analysed for HRQoL (1 year) = 30

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, blood transfusion, dislocations = 60; analysed for HRQoL (1 year) = 40

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; QoL (SF-36; separately reports 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); blood transfusion; length of stay; dislocations; HRQoL (SF-36; physical function; at 1 year); pain (SF-36; bodily pain; at 1 year); mobility and ADL (Musculoskeletal Functional Assessment Instrument Scores; lower score indicates better function; at 1 year)

Note:

- data for minor complications (urinary tract infections, haematoma) and major complications (pulmonary embolism, re-operation) were not reported separately, and we therefore could not use these data in analysis
- we did not report data for deep infection because we could not be certain whether this event was reported for both groups
- it is not clear if scores for HRQoL, mobility, or ADL are mean or median scores; these scores are reported without distribution values

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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. 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.

Raia 2003 *(Continued)*

Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We were not certain whether participants were blinded to the intervention. However, we did not expect lack of blinding to influence reporting of mobility, ADL, or HRQoL.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect lack of blinding of objective measures to be 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.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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 a displaced femoral neck fractures (Garden III and IV) **Exclusion criteria:** cognitive dysfunction (as evidenced by > 4 errors on the SPMSQ); dependency on 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 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

Rashed 2020 *(Continued)*

- 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.
- Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.

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 for HHS = 30; analysed for all other outcomes = 31 **Intervention group 2** • THA cemented 32 mm head total hip replacement (Implantcast GmbH, Germany) • Randomised = 31; losses = 1 (owing to death); analysed for HHS = 30; analysed for all other outcomes = 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:** HHS (categorical data: excellent, good, fair, and poor; at 12 months; and mean scores at 12 months); mortality; superficial wound infection; deep infection; dislocation; DVT **Note:** • For HHS, we included only data at 12 months because we could not be confident in the number of participants for which data were available at earlier time points. • 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:** • 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"

Rashed 2020 *(Continued)*

Allocation concealment (selection bias)	Low risk	Managed by a statistician
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were all performed by senior surgeons but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes. We noted that some outcomes were assessed by a physiotherapist who was blinded to the intervention.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	Participants were not blinded to intervention but unlikely to effect the HRQoL outcome
Blinding of outcome assessment (detection bias) objective outcomes	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	Study authors reported that no participants were lost to follow-up. Only participant loss was because of death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Ravikumar 2000

Study characteristics	
Methods	Quasi-RCT; parallel design **Review comparison group:** THA versus HA **Note:** • This is a 3-arm study that includes a group of participants treated with internal fixation; we did not include these participants in this review.
Participants	**Total number of randomised participants:** 180 **Inclusion criteria:** > 65 years of age; displaced subcapital femoral neck fracture (Gardens III and IV) **Exclusion criteria:** old fractures; pathological fractures; rheumatoid arthritis **Setting:** single centre; UK **Intervention group 1** (THA) • Age, mean: 81.03 years

Ravikumar 2000 *(Continued)*

Intervention group 2 (HA)

- Age, mean: 82.06 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 "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 semi-captive cup and a 32 mm head • Randomised = 89; losses at 2 months = 9, at 12 months = 20, at 13 years = 74; analysed for mortality = 89; analysed at 12 months = 69; analysed at 13 years = 17 **Intervention group 2** • HA; uncemented Austin-Moore prosthesis • Randomised = 91; losses at 2 months = 16, at 12 months = 25, at 13 years = 78; analysed for mortality = 91; analysed at 12 months = 66; analysed at 13 years = 13
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:** pain (at 1 year and 13 years; categorical data: no pain, occasional pain; occasional analgesia; regular analgesia); mobility (at 1 year and 13 years; categorical data: independent (does shopping); independent with aids; housebound unless accompanied; uses aids indoors; chair or bedbound); mortality (2 months, 12 months and 13 years); infection (deep and superficial combined); dislocation; unplanned return to theatre (revision); functional status (HHS) **Notes** • we did not include data for adverse events because these were reported for overall group
Notes	**Funding/sponsorship/declarations of interest:** funding 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.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomised according to the day of the week on which participants were admitted
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation because of the randomisation methods.

Ravikumar 2000 *(Continued)*

Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We were not certain whether participants were blinded to the intervention. However, we did not expect lack of blinding to influence data for participant-reported outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect lack of blinding of objective measures to be influence the outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses were owing to death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report clinical trials registration or pre-published protocol. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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 (Gardens type III and IV); > 60 years of age; either gender **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

Rehman 2014 *(Continued)*

	• 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. • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
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; participants reviewed at 4, 8 and 12 weeks **Intervention group 1** • HA cemented with Thompson prosthesis • Randomised = 55; no reported losses; analysed = 55 **Intervention group 2** • HA uncemented with Austin-Moore prosthesis • Randomised = 55; no reported losses; analysed = 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:** pain (assessed using a pain scale of 0 to 6; higher numbers indicate more pain; at 12 weeks); mobility (scale of 0 to 9; higher scores indicate better mobility; at 12 weeks)
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** August 2010 to August 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation was prepared by a person who was independent of the study; insufficient information
Allocation concealment (selection bias)	Low risk	Use of sealed, opaque, numbered envelopes
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report that all interventions were performed by all same orthopaedic team but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We are uncertain whether participants were blinded to the intervention, but we did expect this influence reporting of data for mobility or pain.

Rehman 2014 *(Continued)*

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

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. • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
Interventions	**General details:** no details of procedure are reported **Intervention group 1** • THA; acetabular and femoral prosthesis used according to individual participant • Randomised = 50; no losses; analysed = 50 **Intervention group 2** • HA; cemented; no additional details • Randomised = 50; no losses; analysed = 50 **Notes:**

Ren 2017 *(Continued)*

- 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 anti-thromboembolics

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:** functional status (HHS; excellent ≥ 90; good = 80 to 90; medium = 70 to 90; poor ≤ 70); time point not specified
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** October 2015 to March 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Participants were randomly divided into groups; no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Unclear risk	We could not be certain of other risks of bias because of limited detail in the methods section.

Sadr 1977

Study characteristics

Methods	RCT; parallel design **Review comparison group:** HA: cemented vs uncemented
Participants	**Total number of randomised participants/cases:** 40 participants/40 cases **Inclusion criteria:** emergency admissions with subcapital fractures of the femoral neck; displaced fractures (Gardens III or IV)

Sadr 1977 *(Continued)*

Exclusion criteria: undisplaced (Gardens 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

Note:

- Study authors did not report baseline characteristics for: smoking history, medication, BMI, comorbidities, mobility assessment, place of residence, cognitive status.
- Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.

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 for mortality = 20; analysed for loosening, dislocation, and functional status = 11 **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 for mortality = 20; analysed for loosening, dislocation, and functional status = 14 **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 anti-thromboembolics
Outcomes	**Outcomes measured/reported by study authors:** loosening of prosthesis; dislocation; ectopic calcification; mortality; functional status **Outcomes relevant to the review:** loosening of prosthesis; dislocation; mortality (6 weeks and 12 months); functional status (excellent = flexion > 90°, no pain, able to walk outdoors unaided; good = flexion 60° to 90°, slight pain, able to walk outdoors with walking aids; fair = flexion 30° to 60°, moderate pain, confined indoors; or poor: flexion under 30° or severe pain) **Note:** • follow-up time period ranged from 3 to 17 months
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** not reported

Sadr 1977 *(Continued)*

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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We are uncertain whether participants were blinded to the intervention, but we did not expect this to influence reporting of data which contributed to the functional status outcome.
Blinding of outcome assessment (detection bias) objective outcomes	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.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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

Santini 2005 *(Continued)*

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.
- Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.

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; losses at hospital discharge = 3 (owing to death); losses at 1 year follow-up = 13 (owing to death); complications at 1 year = 40

Intervention group 2

- HA uncemented endoprosthesis with bipolar head
- Randomised = 53; losses at hospital discharge = 2 (owing to death); losses at 1 year follow-up = 14 (owing to death); complications at 1 year = 39

Note:

- Study authors did not report the following intervention details: number of clinicians (and their skills or experience), use of prophylactic antibiotics and anti-thromboembolics.

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: length of stay (days); ADL (using functional score with VELCA); mobility (using functional score with VELCA, at 12 months); functional status (using total functional score with VELCA, at 12 months); mortality (at hospital discharge and 12 months); postoperative complications (deep wound infections; prosthesis dislocations; intraoperative periprosthetic fracture (iatrotro-

Santini 2005 *(Continued)*

	genic femoral fracture); arrhythmias/MI; UTI; pneumonia/pulmonary embolism); discharge destination (geriatric institutions, home, hospital), all adverse events at 12 months **Notes:** • We did not use data for pneumonia and pulmonary embolism because the data were not reported separately. • VELCA is a study named Verona Elderly Care, in which a scoring system was used to evaluate function; higher scores (to a maximum of 18) indicate better function/walking ability/daily activities.
Notes	**Funding/sponsorship/declarations of interest:** no external funding **Study dates:** September 2000 to December 2001

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quasi-randomised trial; participants allocated to each treatment on alternate days
Allocation concealment (selection bias)	High risk	It is unlikely that allocation could be effectively concealed because of the method of sequence generation.
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding for participant-reported outcomes to influence outcome data.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality and length of stay) would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	All losses were owing to death, which is expected in this population.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Sharma 2016

Study characteristics

Sharma 2016 *(Continued)*

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 • Fracture classification, Gardens 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, Gardens 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. • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
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; losses = 1 (died on POD7); analysed for mortality, wound infection, and dislocation = 40; analysed for HHS = 39 **Intervention group 2** • HA; no additional details • Randomised = 40; losses = 1 (lost to follow-up at 3 months); analysed for mortality, wound infection, and dislocation = 40; analysed for HHS = 39 **Notes:** • study authors did not report the following intervention details: type of anaesthesia, use of prophylactic antibiotics or anti-thromboembolics
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 pre-ambulation status; dislocation; abductor laxity; functional status; early mortality

Sharma 2016 *(Continued)*

	Outcomes relevant to the review: mortality (reported for 1 participant at 7 days); wound infection (superficial and deep infection; assumed time point to be during postoperative period up to 1 week); dislocation; functional status (HHS; at 12 months)
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** 2010 to 2014 **Note:** • We attempted to contact study authors for distribution values for HHS, but we received no reply.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "simple randomisation technique (cards in a box)" Comment: insufficient information to judge whether randomisation is likely to be adequate
Allocation concealment (selection bias)	High risk	Not described. By selecting cards from a box, it is possible that allocation could be manipulated.
Blinding of participants and personnel (performance bias) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were performed by consultant surgeons but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality) would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Loss of one participant in each group, which was explained
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Sims 2018

Study characteristics

Methods	RCT; parallel design **Review comparison group:** HA: ETS versus Thompson
Participants	**Total number of randomised participants:** 964

Sims 2018 *(Continued)*

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
- 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; 311 "full consent"; analysed for HRQoL and length of stay = 315; analysed for mobility = 252; analysed for mortality = 482 **Intervention group 2** • HA cemented Thompson • Randomised = 482; 306 "full consent"; analysed for HRQoL and length of stay = 303; analysed for mobility = 242; analysed for mortality = 482

Sims 2018 *(Continued)*

	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:** EQ-5D-5L (4 months); mobility; mortality (4 months); length of stay **Notes:** • we did not include data for complications in the review because data were not reported according to type of complication • 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 Stryker **Study dates:** February 2015 and March 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "computer-generated random number sequence"
Allocation concealment (selection bias)	Low risk	Quote: "via an online randomization portal"
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	Low risk	Subjective outcomes were obtained by individuals distanced from the surgical team.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	"Participants were blinded to the treatment allocation"
Blinding of outcome assessment (detection bias) objective outcomes	Unclear 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	Large number of participants lost after allocation, but most of these losses are either participants withdrawn before consent or are owing to death
Selective reporting (reporting bias)	Low risk	Prospectively registered with clinical trials register (ISRCTN39085558; first received October 2014). All reported outcomes are consistent with those in the clinical trials documents.

Sims 2018 *(Continued)*

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

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, Gardens 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, Gardens 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. • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
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:**

Sonaje 2017 *(Continued)*

	• study authors did not report the following intervention details: number of clinicians (and their skills or experience), manufacturer names, prophylactic antibiotics or anti-thromboembolics, 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) **Outcomes relevant to the review:** pain (using modified HHS; mean score - higher score indicated less pain); functional status (modified HHS; mean score, and distribution of scores for excellent, good, fair, and poor); periprosthetic fracture **Note:** • We did not include data for mortality or dislocation because it was not clear to which group these participants belonged. We did not include data for individual function tests (e.g. use of walking support) because the method of measurement and the scale and direction of the scale used for this were not clearly defined and we could be certain of the interpretation of mean scores). • 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

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "First simple random technique thereafter alternate systemic random sampling was used" Comment: we have interpreted this as a quasi-randomised method of allocation
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation if an alternative sequence is used.
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We are uncertain whether participants were blinded to the intervention, but we did not expect this to influence reporting of data for mobility or pain.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Although study authors do not report to which group the participants belonged who either died or were lost to follow-up, these losses were only one per group.

Sonaje 2017 *(Continued)*

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

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** **Note:** • Because study authors reported no baseline characteristics, we could not assess whether prognostic factors were comparable between groups.
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 for early mortality and infection = 55; analysed for hip function, pain, and mobility = 40 **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 for early mortality and infection = 57; analysed for hip function, pain, and mobility = 35 **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 anti-thromboembolics, post-operative 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 **Outcomes relevant to the review:** hip function (number of people achieving total score on a scale of 0 to 6, according to D'Aubigne 1954; high scores indicate better hip function (at 6 weeks; 3, 6 and 12 months); pain (number of people achieving total score on a scale of 0 to 6, according to D'Aubigne 1954; high scores indicate least pain; at 6 weeks; 3, 6 and 12 months); mobility (number of people achieving

Sonne-Holm 1982 *(Continued)*

	total score on a scale of 0 to 6, according to D'Aubigne 1954; high scores indicate better mobility; at 6 weeks; 3, 6 and 12 months); mortality (before first follow-up; we assumed that this was at 6 weeks); infection (superficial)
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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	Low risk	Quote: "The patients were evaluated by the authors without knowledge of the type of prosthesis inserted"
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We did not expect lack of blinding for participant-reported outcomes to influence outcome data.
Blinding of outcome assessment (detection bias) objective outcomes	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	Large number of losses, but mostly caused by death which is expected in this population. All losses were well reported.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Stoffel 2013

Study characteristics

Methods	Quasi-RCT; parallel design **Review comparison group:** HA: bipolar versus unipolar
Participants	**Total number of randomised participants:** 294

Stoffel 2013 *(Continued)*

	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, non-ambulatory after surgery, previous symptomatic hip pathology, residence outside the hospital's service zone **Setting:** hospital; single centre; Australia **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. • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
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; overall 33 participants were excluded (11 = communication problems, 3 = refusal to follow-up, 19 = death from unrelated causes); number analysed for complications and length of stay = 133; analysed for modified HHS = 129; analysed for OHS = 126; analysed for pain = 119; analysed for 6MWT = 94 **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; overall 33 participants were excluded (11 = communication problems, 3 = refusal to follow-up, 19 = death from unrelated causes); number analysed for complications and length of stay = 128; analysed for modified HHS = 122; analysed for OHS = 123; analysed for pain = 114; analysed for 6MWT = 92 **Note:** • Study authors did not report the following intervention details: type of anaesthetic, use of prophylactic antibiotics and anti-thromboembolics, 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:** postoperative complications (delirium; dislocation; wound infection - superficial and deep; CVA, DVT; MI, pneumonia; UTI; renal failure/acidosis); length of hospital

Stoffel 2013 *(Continued)*

	stay; functional status at 12 months (modified HHS - more points indicate high functioning); pain at 12 months (verbal numerical rating score; 0 = no pain, 10 = worst imaginable pain); 6MWT at 12 months **Note:** • Study authors report functional status with 2 measurement tools (HHS and OHS). We used the HHS in analysis because this tool was used by other studies in this comparison group.
Notes	**Funding/sponsorship/declarations of interest:** not reported **Study dates:** June 2005 to June 2007

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Study authors report 2 conflicting descriptions of selection: random allocation to groups by coin toss, but all participants in group 1 have an odd year of birth, and all in group 2 have an even year of birth. We have judged this to indicate that the study is quasi-randomised because it appears that participants were allocated to groups according to odd/even year of birth.
Allocation concealment (selection bias)	High risk	It is not possible to conceal allocation because of the quasi-randomised methods used to allocate participants to groups.
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were performed by registrars and consultants but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We are uncertain whether participants were blinded to the intervention, but we did not expect this to influence reporting of data for mobility or pain.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	We could not be certain whether losses (which were approximately 11%), and reasons for these losses, were balanced between groups because the number randomised to each group was not reported. We also noted a higher number of losses for measurement of mobility which were not explained, and variable losses for participant-reported outcomes.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Talsnes 2013

Study characteristics

Methods	RCT; parallel design

Talsnes 2013 *(Continued)*

Review comparison group: HA: cemented versus uncemented

Participants	**Total number of randomised participants:** 334 **Inclusion criteria:** admitted for cervical hip fracture with displaced Gardens III to IV fractures; > 75 years of age **Exclusion criteria:** 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. • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
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 for all outcomes = 162 **Intervention group 2** • HA uncemented; bipolar implant (Landos Corail, Depuy, Warshaw, IN, USA) • Randomised = 172; no reported losses; analysed for all outcomes = 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 anti-thromboembolics, post-operative 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); need for blood transfusion (≥ 2 units PRBC before discharge)
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

Talsnes 2013 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors did not describe how many surgeons were involved in the study and whether they were equally experienced with the types of implants used in this study.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality and blood transfusion) would influence objective outcome data .
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
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.
Other bias	Low risk	We identified no other sources of bias.

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

Taylor 2012 *(Continued)*

Baseline characteristics (overall)

- Age, mean (range): 85.2 (70 to 99.4) years

Intervention group 1 (cemented)

- 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.
- Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.

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 for all outcomes = 80 **Intervention group 2** • HA uncemented; Zweymüller Alloclassic stem with an appropriated sized head (Centerpulse, Zurich, Switzerland) • Randomised = 80; no losses; analysed for all outcomes = 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:** length of hospital stay; mortality (6 weeks, 1 year); unplanned return to theatre (assumed to be within 2-year follow-up period); complications (respiratory infections, superficial or deep wound infections, UTI, postoperative and intraoperative fractures, dislocation); dis-

Taylor 2012 *(Continued)*

	charge destination (discharged to own home); pain (VAS); functional status (OHS); mobility (TUG and use of walking aids) **Note:** • Study authors did not report data for cognitive function. • Study authors reported functional status using 2 measurement tools (OHS and SMFA). We reported data from the OHS scale because this was reported more frequently by studies in the review. Similarly, study authors reported 2 measures for mobility (TUG and walking aids), and we reported data using TUG because this was more frequently reported. • Unplanned return to theatre: reasons for re-operation not reported; types of re-operation were not reported • We used data supplied by study authors in the previous version of the review for superficial and deep infections (Parker 2010a).
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

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) objective outcomes	Low risk	It is not possible to blind surgeons to treatment groups. The surgeons in the study were experienced in both techniques and we did not expect that lack of blinding would influence outcome performance or outcome data.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	Low risk	Quote: "All clinical variables were assessed by an unbiased observer (a research nurse who was not involved in the surgery or clinical decisions and who was blinded to the treatment group"
Blinding of outcome assessment (detection bias) participant-reported outcomes	Low risk	We are uncertain whether participants were blinded to the intervention, but we did not expect this to influence reporting of data for mobility, pain or ability to live independently.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality and length of stay) would influence objective outcome data.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No participant losses
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.
Other bias	Low risk	We identified no other sources of bias.

Van den Bekerom 2010

Study characteristics	
Methods	RCT; parallel design **Review comparison group:** THA versus HA
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. • Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
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 participant 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

Van den Bekerom 2010 *(Continued)*

- 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

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); length of hospital stay; functional status (modified HHS, pain using HHS, function using HHS; at 12 months, 5 years, and 12 years); revision surgery (at 12 months, 5 years, and 12 years); dislocation (at 5 years, and at 12 years); loosening of femoral component (at 5 years, and at 12 years); superficial infection; deep infection; pulmonary embolism; pneumonia; CVA; delirium **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 a previous version of this review (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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. 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.

Van den Bekerom 2010 *(Continued)*

Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality and length of stay) would influence objective outcome data.
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.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

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; participants with sustained pathological fracture; presence of local or systemic infection; hip osteoarthritis; complete preinjury 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.

Vidovic 2013 *(Continued)*

	• Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.
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-deltaparin 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; 8 (7 died; 1 unexplained loss); analysed for mortality and length of hospital stay = 38; analysed for HHS = 30 **Intervention group 2** • HA uncemented; modular Austin-Moore • Randomised = 41; losses = 11 (9 died; 2 explained losses); analysed for mortality and length of hospital stay = 41; analysed for HHS = 30 **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 **Outcomes relevant to the review:** length of in-hospital stay; mortality (12 months); HHS (at 3 and 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

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "patients were randomized into group A and B by an envelope" Comment: insufficient information
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. 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) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias)	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality and length of stay) would influence objective outcome data.

Vidovic 2013 *(Continued)*

objective outcomes

Incomplete outcome data (attrition bias) All outcomes	Low risk	We noted a discrepancy in the number of reported losses and the number of deaths. However, because this discrepancy was for only one participant, we used data in the results section for mortality to infer the number of losses. Most losses were owing to death.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report pre-published protocol or clinical trials registration. It is not feasible to effectively assess risk of selective reporting bias without these documents.
Other bias	Low risk	We identified no other sources of bias.

Xu 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 • 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. • Study authors do not confirm displaced or undisplaced fractures.

Xu 2017 *(Continued)*

- Study authors reported insufficient baseline details for us to assess whether prognostic factors were comparable between groups.

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 anti-thromboembolics 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 for HHS at 5 years = 33; analysed for all other outcomes = 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 for HHS at 5 years = 31; analysed for all other outcomes = 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:** length of hospital stay; mortality (5 years); HHS (1 and 5 years); complications (deep infection, prosthetic loosening, dislocation, periprosthetic fracture; all at 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) objective outcomes	Unclear risk	It is not possible to blind surgeons to treatment groups. Study authors report that the interventions were performed by an experienced surgeon but we could not be certain whether surgeons were equally experienced in using the study implants.
Blinding of outcome assessment (detection bias) clinically-assessed subjective outcomes	High risk	It is not possible to blind surgeons to treatment groups. We judged that knowledge of the type/fixation method of arthroplasty could influence judgments made by surgeons when assessing subjective outcomes.
Blinding of outcome assessment (detection bias) objective outcomes	Low risk	We did not expect that lack of blinding of assessors of objective measures (mortality and length of stay) would influence objective outcome data.

Xu 2017 *(Continued)*

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

ADL: activities of daily living; AHS: manufacturers name for implant; 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; CCI: Charlson Comorbidity Index; CPCS: Collarless Polished Cemented Stem; CPT: collarless, polished, double-taper design concept; CT: chromatography; CTU: Clinical Trials Unit; CVA: cerebrovascular accident; DB: manufacturers name for implant; DM: dual mobility; DSM-5: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition; DVT: deep vein thrombosis; EQ-5D: European 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; ICECAP-O: ICEpop CAPability measure for older people; IQR: interquartile range; ISS: Injury Severity Score; ITT: intention-to-treat; IU: international units; IV: intravenous(ly); LD/Fx: manufacturers name for implant; M/F: male/female; MI: myocardial infarction; MMSE: Mini-Mental State Examination; MRI: magnetic resonance imaging; NICE: National Institute for Health and Care Excellence; NMS: New Mobility Score; 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; 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; 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 not eligible.
ISRCTN42349821	Abandoned due to lack of funding
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.
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.
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.

Study	Reason for exclusion
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.

HA: hemiarthroplasty
RCT: randomised controlled trial
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 III or IV acute hip fracture **Exclusion criteria**: person or relative refuse enrollment **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 the 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 III to IV Garden femoral neck fracture or a fracture Garden 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
HA: hemiarthroplasty
HRQoL: health-related quality of life
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]*

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	**Expected number of participants**:100 **Inclusion criteria**: people who are willing to participate 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	Recruiting, expected completion date 2 October 2019

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	**Expected 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.

ISRCTN15606075 *(Continued)*

	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	Expected to complete 15 November 2021

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	**Expected 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

NCT01578408 *(Continued)*

	Comparison THA (cemented) versus THA (modern uncemented)
Participants	**Expected 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 live independently. **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; reoperation; HRQoL (EQ-5D); activity level (UCLA); function (HHS). Follow-up visits at 3, 6 months, 1, 2, 5, 7, 10 years.
Starting date	11 May 2010
Contact information	Johan Kärrholm, Orthopaedic Department, Sahlgrenska University Hospital, Gothenburg, Sweden
Notes	Outcome data collection completed 19 February 2020

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	**Expected number of participants**: 150 **Inclusion criteria**: people aged > 70 years with displaced femoral neck fractures (Garden 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

NCT01787929 *(Continued)*

Contact information	bernard-de-dompsure.r@chu-nice.fr
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	**Expected 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 October 2013
Contact information	Yukiharu Hasegawa; taekgami-toyomh@umin.ac.jp
Notes	Recruiting

Wolf 2020

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	**Expected number of participants**: 1600 **Inclusion criteria**: > 65 years of age, with a displaced femoral neck fracture who are eligible for a THA ; Garden 3–4 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

Wolf 2020 *(Continued)*

	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; reoperation; mortality; HRQoL (EQ-5D)
Starting date	January 2020
Contact information	olof.wolf@surgsci.uu.se
Notes	

ASA: American Society of Anesthesiologists
BMI: body mass index
CDC: Centre for Disease Control
CT: computed tomography
DEXA: dual energy x-ray absorptiometry
EQ-5D: EuroQoL 5 Dimensions instrument
EQ-5D-5L: EuroQoL 5 Dimensions, 5 levels instrument
HA: hemiarthroplasty
HHS: Harris hip score
HRQoL: health-related quality of life
JHEQ: Japanese Orthopaedic Association hip disease evaluation questionnaire
JOA: Japanese Orthopaedic Association
OHS: Oxford hip score
RA: rheumatoid arthritis
RCT: randomised controlled trial
RSA: radiostereometric analysis
SF-36: Short form-36
SLE: systemic lupus erythematosis
SPMSQ: short portable mental status questionnaire
UCLA: University of California, Los Angeles
THA: total hip arthroplasty
VAS: visual analogue score
WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index

DATA AND ANALYSES

Comparison 1. THA: cemented vs uncemented

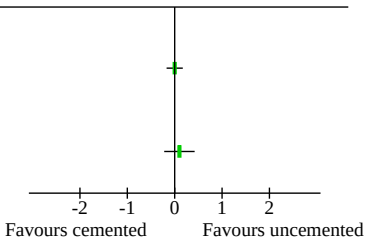
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 ADL (measurement tool not defined)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1.1 Early (≤ 4 months)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1.2 At 12 months	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.2 Functional status (using HHS, range for scores from 0 to 100; higher scores indicate better function)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.2.1 Early (reported at ≤ 4 months)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.2.2 At 12 months	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.3 HRQoL (using EQ-5D, range of scores from o to 1; higher scores indicate better quality of life)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.3.1 Early (≤ 4 months)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.3.2 At 12 months	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.4 Mortality (12 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.5 Unplanned return to theatre (end of follow-up)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.6 Pain (using PNRS, range of scores from 0 to 11: lower values indicate less pain)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.6.1 Early (reported at ≤ 4 months	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.6.2 Reported at 12 months	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.7 Adverse events related to the implant, fracture, or both	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.7.1 Intraoperative periprosthetic fracture	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.7.2 Postoperative periprosthetic fracture	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.7.3 Loosening	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.7.4 Superficial infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

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

Analysis 1.1. Comparison 1: THA: cemented vs uncemented, Outcome 1: ADL (measurement tool not defined)

	Cemented			Uncemented			Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	IV, Fixed, 95% CI	IV, Fixed, 95% CI
1.1.1 Early (≤ 4 months)								
Chammout 2017 (1)	1.1	0.4	34	1.1	0.3	31	0.00 [-0.17 , 0.17]	
1.1.2 At 12 months								
Chammout 2017 (2)	1.2	0.7	33	1.1	0.6	30	0.10 [-0.22 , 0.42]	



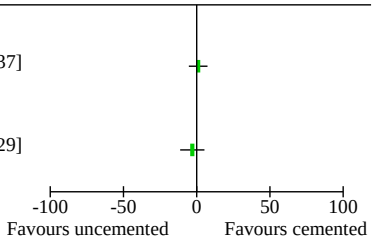
Footnotes

(1) THA1: cemented, modular CPT, 32mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 32mm head, cemented cup (3 months)

(2) THA1: cemented, modular CPT, 32mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 32mm head, cemented cup (12 months)

Analysis 1.2. Comparison 1: THA: cemented vs uncemented, Outcome 2: Functional status (using HHS, range for scores from 0 to 100; higher scores indicate better function)

	Cemented			Uncemented			Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	IV, Fixed, 95% CI	IV, Fixed, 95% CI
1.2.1 Early (reported at ≤ 4 months)								
Chammout 2017 (1)	73	12	34	72	14	31	1.00 [-5.37 , 7.37]	
1.2.2 At 12 months								
Chammout 2017 (2)	79	19	34	82	15	31	-3.00 [-11.29 , 5.29]	



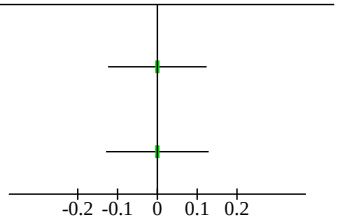
Footnotes

(1) Harris Hip Score; THA1: cemented, modular CPT, 32mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 32mm head, cemented cup; at 3 months

(2) Harris Hip Score; THA1: cemented, modular CPT, 32mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 32mm head, cemented cup; at 12 months

Analysis 1.3. Comparison 1: THA: cemented vs uncemented, Outcome 3: HRQoL (using EQ-5D, range of scores from o to 1; higher scores indicate better quality of life)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
1.3.1 Early (≤ 4 months)							
Chammout 2017 (1)	0.7	0.3	34	0.7	0.2	30	0.00 [-0.12 , 0.12]
1.3.2 At 12 months							
Chammout 2017 (2)	0.8	0.2	33	0.8	0.3	29	0.00 [-0.13 , 0.13]



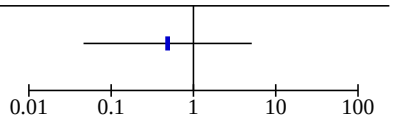
Footnotes

(1) EQ-5D (higher scores indicate better quality of life); THA1: cemented, modular CPT, 32mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 32m

(2) EQ-5D (higher scores indicate better quality of life); THA1: cemented, modular CPT, 32mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 32m

Analysis 1.4. Comparison 1: THA: cemented vs uncemented, Outcome 4: Mortality (12 months)

Study or Subgroup	Cemented Events	Total	Uncemented Events	Total	Risk Ratio M-H, Fixed, 95% CI
Chammout 2017 (1)	1	35	2	34	0.49 [0.05 , 5.11]

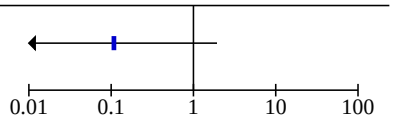


Footnotes

(1) THA1: cemented, modular CPT, 32 mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 32 mm head, cemented cup; at 12 months

Analysis 1.5. Comparison 1: THA: cemented vs uncemented, Outcome 5: Unplanned return to theatre (end of follow-up)

Study or Subgroup	Cemented Events	Total	Uncemented Events	Total	Risk Ratio M-H, Fixed, 95% CI
Chammout 2017 (1)	0	35	4	34	0.11 [0.01 , 1.93]



Footnotes

(1) THA1: cemented, modular CPT, 32mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 32mm head, cemented cup; 24 months

Analysis 1.6. Comparison 1: THA: cemented vs uncemented, Outcome 6: Pain (using PNRS, range of scores from 0 to 11: lower values indicate less pain)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Mean Difference IV, Fixed, 95% CI
1.6.1 Early (reported at ≤ 4 months							
Chammout 2017 (1)	2.1	1	34	3	2.4	30	-0.90 [-1.82 , 0.02]
1.6.2 Reported at 12 months							
Chammout 2017 (2)	2.1	2.4	34	1.1	1.5	29	1.00 [0.03 , 1.97]

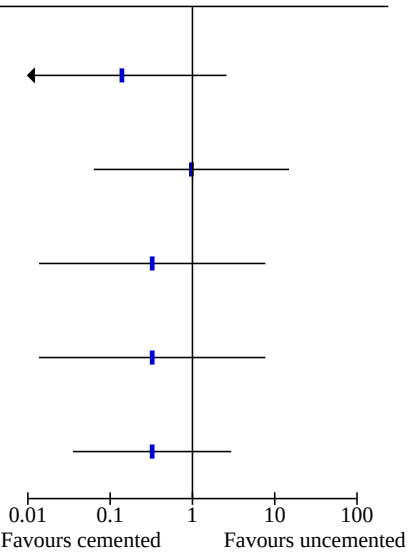
Footnotes

(1) Pain numerical rating scale (lower scores indicate less pain); THA1: cemented, modular CPT, 32mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 3

(2) Pain numerical rating scale (lower scores indicate less pain); THA1: cemented, modular CPT, 32mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 3

Analysis 1.7. Comparison 1: THA: cemented vs uncemented, Outcome 7: Adverse events related to the implant, fracture, or both

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Risk Ratio M-H, Fixed, 95% CI
1.7.1 Intraoperative periprosthetic fracture					
Chammout 2017 (1)	0	35	3	34	0.14 [0.01 , 2.59]
1.7.2 Postoperative periprosthetic fracture					
Chammout 2017	1	35	1	34	0.97 [0.06 , 14.91]
1.7.3 Loosening					
Chammout 2017	0	35	1	34	0.32 [0.01 , 7.69]
1.7.4 Superficial infection					
Chammout 2017	0	35	1	34	0.32 [0.01 , 7.69]
1.7.5 Dislocation					
Chammout 2017	1	35	3	34	0.32 [0.04 , 2.96]



Footnotes

(1) THA1: cemented, modular CPT, 32 mm head, cemented cup; THA2: uncemented, Bi-Metric stem, 32 mm head, cemented cup; at 3 months

Comparison 2. HA: cemented vs uncemented

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.1 Early ADL (≤ 4 months, continuous data)	4	1275	Std. Mean Difference (IV, Random, 95% CI)	-0.03 [-0.21, 0.16]
2.2 Early ADL (≤ 4 months, categorical data)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2.3 ADL (12 months, continuous data)	5	1173	Std. Mean Difference (IV, Random, 95% CI)	-0.09 [-0.21, 0.02]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.3.1 First generation uncemented stem	1	106	Std. Mean Difference (IV, Random, 95% CI)	-0.18 [-0.56, 0.20]
2.3.2 Modern stem	4	1067	Std. Mean Difference (IV, Random, 95% CI)	-0.08 [-0.20, 0.04]
2.4 ADL (12 months, categorical data)	1		Risk Ratio (IV, Fixed, 95% CI)	Totals not selected
2.5 Late ADL (> 24 months; categorical data)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2.6 Delirium (end of follow-up)	2	800	Risk Ratio (M-H, Random, 95% CI)	1.06 [0.55, 2.06]
2.6.1 First generation uncemented stem	1	400	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.14, 7.03]
2.6.2 Modern stem	1	400	Risk Ratio (M-H, Random, 95% CI)	1.07 [0.53, 2.16]
2.7 Early functional status (≤ 4 months, continuous data)	3	416	Mean Difference (IV, Random, 95% CI)	3.38 [0.05, 6.70]
2.7.1 First generation uncemented stem	1	79	Mean Difference (IV, Random, 95% CI)	4.21 [1.77, 6.65]
2.7.2 Modern stem	2	337	Mean Difference (IV, Random, 95% CI)	2.43 [-4.42, 9.29]
2.8 Early functional status (≤ 4 months; categorical data)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2.9 Early functional status: extracapsular fractures (≤ 4 months. HHS; higher scores indicate better function)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
2.10 Functional status (12 months; continuous data using HHS, OHS and VELCA; higher scores indicate better function)	5	494	Std. Mean Difference (IV, Random, 95% CI)	0.13 [-0.09, 0.35]
2.10.1 First generation uncemented stem	2	166	Std. Mean Difference (IV, Random, 95% CI)	0.32 [-0.30, 0.94]
2.10.2 Modern stem	3	328	Std. Mean Difference (IV, Random, 95% CI)	0.04 [-0.18, 0.25]
2.11 Functional status (12 months, categorical data using HHS)	2	100	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.91, 1.45]
2.12 Functional status: extracapsular fractures (12 months. HHS; higher scores indicate improved function)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.13 Late functional status (> 24 months using HHS; higher scores indicate better function)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
2.14 Early HRQoL (≤ 4 months)	3	1122	Std. Mean Difference (IV, Random, 95% CI)	0.20 [0.07, 0.34]
2.15 HRQoL (12 months)	3	1079	Std. Mean Difference (IV, Random, 95% CI)	0.12 [-0.00, 0.24]
2.16 Late HRQoL (> 24 months)	1	71	Mean Difference (IV, Fixed, 95% CI)	-0.09 [-0.23, 0.05]
2.17 Early mobility (≤ 4 months, independent mobility)	3	980	Risk Ratio (M-H, Random, 95% CI)	1.04 [0.95, 1.14]
2.17.1 First generation uncemented stem	1	75	Risk Ratio (M-H, Random, 95% CI)	1.58 [0.84, 2.95]
2.17.2 Modern stem	2	905	Risk Ratio (M-H, Random, 95% CI)	1.03 [0.95, 1.12]
2.18 Early mobility (≤ 4 months, continuous data)	3	766	Std. Mean Difference (IV, Random, 95% CI)	-0.26 [-0.40, -0.12]
2.18.1 First generation uncemented stem	1	327	Std. Mean Difference (IV, Random, 95% CI)	-0.36 [-0.58, -0.14]
2.18.2 Modern stem	2	439	Std. Mean Difference (IV, Random, 95% CI)	-0.18 [-0.37, 0.00]
2.19 Early mobility (mean reduction values at ≤ 4 months; higher scores indicate better mobility)	1	110	Mean Difference (IV, Fixed, 95% CI)	-0.40 [-0.68, -0.12]
2.20 Mobility (12 months, continuous data using different mobility scales; lower scores indicate better mobility)	4	762	Std. Mean Difference (IV, Random, 95% CI)	-0.24 [-0.42, -0.06]
2.20.1 First generation uncemented stem	2	386	Std. Mean Difference (IV, Random, 95% CI)	-0.12 [-0.54, 0.30]
2.20.2 Modern stem	2	376	Std. Mean Difference (IV, Random, 95% CI)	-0.32 [-0.53, -0.12]
2.21 Mobility (12 months, independent mobility)	3	826	Risk Ratio (M-H, Random, 95% CI)	0.98 [0.70, 1.37]
2.21.1 First generation uncemented stem	1	75	Risk Ratio (M-H, Random, 95% CI)	1.22 [0.81, 1.82]
2.21.2 Modern	2	751	Risk Ratio (M-H, Random, 95% CI)	0.90 [0.52, 1.55]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.22 Mobility (12 months, dependent on walking aid)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2.23 Late mobility (> 24 months)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
2.24 Late mobility (> 24 months; independent mobility)	1	79	Risk Ratio (M-H, Fixed, 95% CI)	0.88 [0.75, 1.02]
2.25 Early mortality (≤ 4 months)	12	3136	Risk Ratio (M-H, Random, 95% CI)	0.95 [0.80, 1.13]
2.25.1 First generation uncemented stem	7	980	Risk Ratio (M-H, Random, 95% CI)	1.10 [0.79, 1.54]
2.25.2 Modern stem	5	2156	Risk Ratio (M-H, Random, 95% CI)	0.90 [0.73, 1.10]
2.26 Mortality (12 months)	15	3727	Risk Ratio (M-H, Random, 95% CI)	0.86 [0.78, 0.96]
2.26.1 First generation uncemented stem	8	1036	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.78, 1.18]
2.26.2 Modern stem	7	2691	Risk Ratio (M-H, Random, 95% CI)	0.83 [0.73, 0.94]
2.27 Late mortality (> 24 months)	2	620	Risk Ratio (M-H, Random, 95% CI)	1.01 [0.89, 1.15]
2.28 Unplanned return to theatre (end of follow-up)	6	2336	Risk Ratio (M-H, Random, 95% CI)	0.70 [0.45, 1.10]
2.28.1 First generation uncemented stem	1	400	Risk Ratio (M-H, Random, 95% CI)	0.61 [0.30, 1.26]
2.28.2 Modern stem	5	1936	Risk Ratio (M-H, Random, 95% CI)	0.77 [0.44, 1.35]
2.29 Early pain (≤ 4 months, experiencing no pain)	4	500	Risk Ratio (M-H, Random, 95% CI)	1.11 [1.00, 1.22]
2.29.1 First generation uncemented stem	2	194	Risk Ratio (M-H, Random, 95% CI)	1.26 [0.81, 1.97]
2.29.2 Modern stem	2	306	Risk Ratio (M-H, Random, 95% CI)	1.05 [0.88, 1.24]
2.30 Early pain (≤ 4 months; mean scores, lower scores indicate less pain)	4	1507	Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.09, 0.11]
2.30.1 First generation uncemented stem	1	320	Mean Difference (IV, Fixed, 95% CI)	-0.60 [-0.87, -0.33]

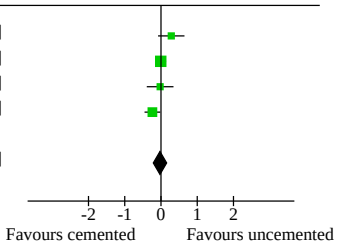
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.30.2 Modern stem	3	1187	Mean Difference (IV, Fixed, 95% CI)	0.10 [-0.01, 0.20]
2.31 Pain (12 months, experiencing no pain)	4	376	Risk Ratio (M-H, Random, 95% CI)	1.17 [0.85, 1.63]
2.31.1 First generation uncemented stem	2	114	Risk Ratio (M-H, Random, 95% CI)	2.09 [0.97, 4.48]
2.31.2 Modern stem	2	262	Risk Ratio (M-H, Random, 95% CI)	0.93 [0.82, 1.06]
2.32 Pain (12 months, using continuous data; lower values indicate less pain)	5	1305	Std. Mean Difference (IV, Random, 95% CI)	-0.02 [-0.21, 0.18]
2.32.1 First generation uncemented stem	1	272	Std. Mean Difference (IV, Random, 95% CI)	-0.32 [-0.56, -0.08]
2.32.2 Modern stem	4	1033	Std. Mean Difference (IV, Random, 95% CI)	0.09 [-0.03, 0.21]
2.33 Pain (12 months; mean reduction values: lower scores indicate less pain)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
2.34 Late pain (> 24 months, using mean scores; lower scores indicate less pain)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
2.35 Late pain (> 24 months; experiencing no pain)	1	80	Risk Ratio (M-H, Fixed, 95% CI)	1.00 [0.77, 1.30]
2.36 Length of hospital stay (days)	9	1741	Mean Difference (IV, Random, 95% CI)	-0.40 [-1.03, 0.23]
2.36.1 First generation uncemented stem	5	765	Mean Difference (IV, Random, 95% CI)	-0.64 [-1.84, 0.55]
2.36.2 Modern stem	4	976	Mean Difference (IV, Random, 95% CI)	-0.43 [-1.73, 0.88]
2.37 Discharge destination (own home)	6	2231	Risk Ratio (M-H, Random, 95% CI)	1.05 [0.98, 1.13]
2.37.1 First generation uncemented stem	2	501	Risk Ratio (M-H, Random, 95% CI)	0.98 [0.71, 1.34]
2.37.2 Modern stem	4	1730	Risk Ratio (M-H, Random, 95% CI)	1.07 [0.95, 1.20]
2.38 Adverse events related to the implant, fracture, or both	14		Risk Ratio (M-H, Random, 95% CI)	Subtotals only

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.38.1 Intraoperative periprosthetic fracture	7	1669	Risk Ratio (M-H, Random, 95% CI)	0.20 [0.08, 0.46]
2.38.2 Postoperative periprosthetic fracture	8	2819	Risk Ratio (M-H, Random, 95% CI)	0.29 [0.14, 0.57]
2.38.3 Loosening	4	537	Risk Ratio (M-H, Random, 95% CI)	0.52 [0.14, 1.89]
2.38.4 Deep infection	7	1382	Risk Ratio (M-H, Random, 95% CI)	1.56 [0.72, 3.38]
2.38.5 Superficial infection	10	3038	Risk Ratio (M-H, Random, 95% CI)	1.23 [0.73, 2.06]
2.38.6 Dislocation	10	3032	Risk Ratio (M-H, Random, 95% CI)	1.08 [0.61, 1.91]
2.39 Adverse events unrelated to the implant, fracture, or both	11		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
2.39.1 Acute kidney injury	4	2226	Risk Ratio (M-H, Random, 95% CI)	1.23 [0.76, 2.00]
2.39.2 Blood transfusion	7	2907	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.83, 1.20]
2.39.3 Cerebrovascular accident	5	2356	Risk Ratio (M-H, Random, 95% CI)	0.93 [0.41, 2.10]
2.39.4 Pneumonia/chest infection	8	2789	Risk Ratio (M-H, Random, 95% CI)	0.78 [0.50, 1.21]
2.39.5 Myocardial infarction	7	2682	Risk Ratio (M-H, Random, 95% CI)	0.91 [0.44, 1.89]
2.39.6 Urinary tract infection	5	1745	Risk Ratio (M-H, Random, 95% CI)	0.89 [0.65, 1.20]
2.39.7 Venous thromboembolic phenomena (DVT)	7	2661	Risk Ratio (M-H, Random, 95% CI)	1.28 [0.56, 2.90]
2.39.8 Venous thromboembolic phenomena (pulmonary embolism)	6	2499	Risk Ratio (M-H, Random, 95% CI)	3.56 [1.26, 10.11]

Analysis 2.1. Comparison 2: HA: cemented vs uncemented, Outcome 1: Early ADL (≤ 4 months, continuous data)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Weight	Std. Mean Difference IV, Random, 95% CI
DeAngelis 2012 (1)	-3.4	1.1	58	-3.7	1	59	16.8%	0.28 [-0.08 , 0.65]
Fernandez 2022 (2)	3.14	1.52	366	3.15	1.52	349	37.5%	-0.01 [-0.15 , 0.14]
Moerman 2017 (3)	45.3	16.6	62	45.7	17	52	16.5%	-0.02 [-0.39 , 0.34]
Parker 2020 (4)	4.2	1.71	164	4.6	1.66	165	29.2%	-0.24 [-0.45 , -0.02]
Total (95% CI)			**650**			**625**	**100.0%**	**-0.03 [-0.21 , 0.16]**

Heterogeneity: Tau² = 0.02; Chi² = 6.40, df = 3 (P = 0.09); I² = 53%
Test for overall effect: Z = 0.30 (P = 0.77)
Test for subgroup differences: Not applicable

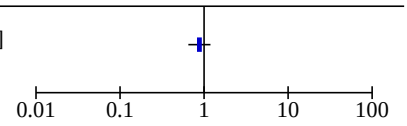


Footnotes

(1) OARS-IADL (higher scores indicate more independence; we inverted data in meta-analysis). HA1: cemented, VerSys stem, unipolar; HA2: uncemented, beaded stem, unipolai
(2) 'Usual activities' - derived from EQ-5D utility index, using 5-point Likert scale; HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at su
(3) GARS (lower scores indicate more independence). HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 3 months
(4) Social dependency scale (lower scores indicate more independence). HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 4 months

Analysis 2.2. Comparison 2: HA: cemented vs uncemented, Outcome 2: Early ADL (≤ 4 months, categorical data)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Risk Ratio M-H, Fixed, 95% CI
Figved 2009 (1)	44	100	45	90	0.88 [0.65 , 1.19]

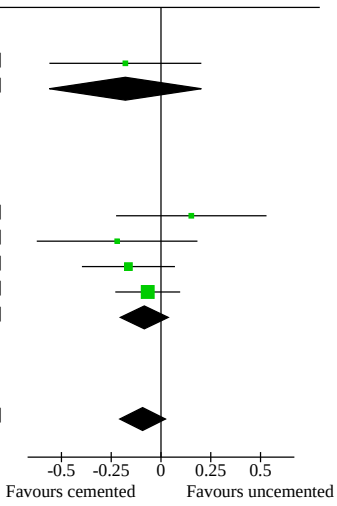


Footnotes

(1) Number of people scoring 19 or 20 on a 20-point Barthel Index scale; HA1: uncemented, modular, bipolar; HA2: uncemented, modular, u

Analysis 2.3. Comparison 2: HA: cemented vs uncemented, Outcome 3: ADL (12 months, continuous data)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
2.3.1 First generation uncemented stem								
Santini 2005 (1)	-1.73	1.75	53	-1.42	1.69	53	9.0%	-0.18 [-0.56 , 0.20]
Subtotal (95% CI)			**53**			**53**	**9.0%**	**-0.18 [-0.56 , 0.20]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.92 (P = 0.36)								
2.3.2 Modern stem								
DeAngelis 2012 (2)	-3.2	1.4	54	-3.4	1.2	54	9.2%	0.15 [-0.23 , 0.53]
Moerman 2017 (3)	39.2	16.5	53	43.2	19.7	43	8.1%	-0.22 [-0.62 , 0.18]
Parker 2020 (4)	3.8	1.82	147	4.1	1.84	136	24.1%	-0.16 [-0.40 , 0.07]
Fernandez 2022 (5)	3.01	1.49	300	3.11	1.51	280	49.6%	-0.07 [-0.23 , 0.10]
Subtotal (95% CI)			**554**			**513**	**91.0%**	**-0.08 [-0.20 , 0.04]**
Heterogeneity: Tau² = 0.00; Chi² = 2.43, df = 3 (P = 0.49); I² = 0%								
Test for overall effect: Z = 1.37 (P = 0.17)								
Total (95% CI)			**607**			**566**	**100.0%**	**-0.09 [-0.21 , 0.02]**
Heterogeneity: Tau² = 0.00; Chi² = 2.65, df = 4 (P = 0.62); I² = 0%								
Test for overall effect: Z = 1.58 (P = 0.11)								
Test for subgroup differences: Chi² = 0.22, df = 1 (P = 0.64), I² = 0%								

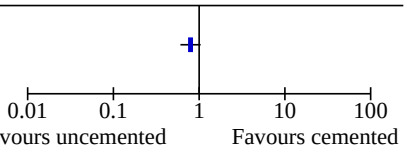


Footnotes

(1) VELCA functional scores (higher scores indicate indicate increased independence; direction is inverted for this analysis); HA1: cemented, unipolar; HA2: uncemented, unipol
(2) OARS-IADL (higher scores indicate increased independence; we inverted data in meta-analysis). HA1: cemented, VerSys stem, unipolar; HA2: uncemented, beaded stem, uni
(3) GARS (lower scores indicate indicate increased independence). HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar; at 12 months
(4) Social dependency scale (lower scores indicate increased independence). HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 12 months
(5) 'Usual activities' - derived from EQ-5D utility index, using 5-point Likert scale; HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at su

Analysis 2.4. Comparison 2: HA: cemented vs uncemented, Outcome 4: ADL (12 months, categorical data)

Study or Subgroup	Cemented Events	Total	Uncemented Events	Total	Risk Ratio IV, Fixed, 95% CI
Figved 2009 (1)	45	91	48	77	0.79 [0.61 , 1.04]

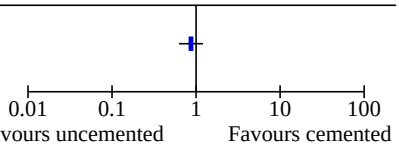


Footnotes

(1) Reported as Barthel Index (scores of 19 or 20); HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 12 montl

Analysis 2.5. Comparison 2: HA: cemented vs uncemented, Outcome 5: Late ADL (> 24 months; categorical data)

Study or Subgroup	Cemented Events	Total	Uncemented Events	Total	Risk Ratio M-H, Fixed, 95% CI
Figved 2009 (1)	25	42	26	38	0.87 [0.63 , 1.21]

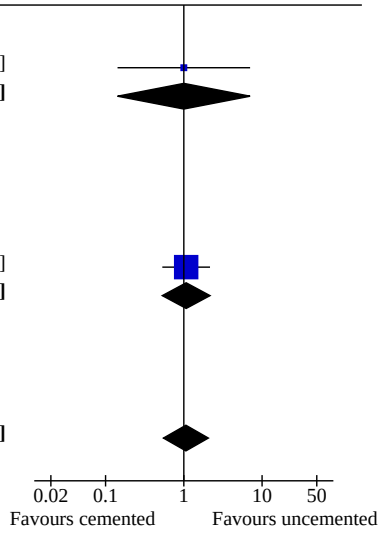


Footnotes

(1) Reported as Barthel Index (scores of 19 or 20); HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 5 years

Analysis 2.6. Comparison 2: HA: cemented vs uncemented, Outcome 6: Delirium (end of follow-up)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.6.1 First generation uncemented stem						
Parker 2010c (1)	2	200	2	200	11.5%	1.00 [0.14 , 7.03]
Subtotal (95% CI)		**200**		**200**	**11.5%**	**1.00 [0.14 , 7.03]**
Total events:	2		2			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.00 (P = 1.00)						
2.6.2 Modern stem						
Parker 2020 (2)	15	200	14	200	88.5%	1.07 [0.53 , 2.16]
Subtotal (95% CI)		**200**		**200**	**88.5%**	**1.07 [0.53 , 2.16]**
Total events:	15		14			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.19 (P = 0.85)						
Total (95% CI)		**400**		**400**	**100.0%**	**1.06 [0.55 , 2.06]**
Total events:	17		16			
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.95); I² = 0%						
Test for overall effect: Z = 0.18 (P = 0.86)						
Test for subgroup differences: Chi² = 0.00, df = 1 (P = 0.95), I² = 0%						

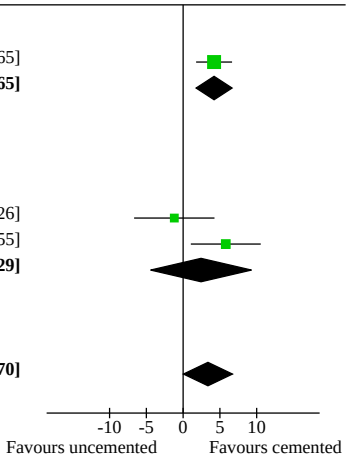


Footnotes

(1) Acute confusional state. HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 60 months
(2) HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 12 months

Analysis 2.7. Comparison 2: HA: cemented vs uncemented, Outcome 7: Early functional status (≤ 4 months, continuous data)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Weight	Mean Difference IV, Random, 95% CI
2.7.1 First generation uncemented stem								
Vidovic 2013 (1)	66.74	5.32	38	62.53	5.76	41	48.3%	4.21 [1.77 , 6.65]
Subtotal (95% CI)			**38**			**41**	**48.3%**	**4.21 [1.77 , 6.65]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 3.38 (P = 0.0007)								
2.7.2 Modern stem								
Figved 2009 (2)	70.9	18.5	99	72.1	19.7	90	23.7%	-1.20 [-6.66 , 4.26]
Movrin 2020 (3)	77.1	13.1	72	71.3	16.3	76	28.0%	5.80 [1.05 , 10.55]
Subtotal (95% CI)			**171**			**166**	**51.7%**	**2.43 [-4.42 , 9.29]**
Heterogeneity: Tau² = 17.68; Chi² = 3.59, df = 1 (P = 0.06); I² = 72%								
Test for overall effect: Z = 0.70 (P = 0.49)								
Total (95% CI)			**209**			**207**	**100.0%**	**3.38 [0.05 , 6.70]**
Heterogeneity: Tau² = 4.41; Chi² = 4.00, df = 2 (P = 0.14); I² = 50%								
Test for overall effect: Z = 1.99 (P = 0.05)								
Test for subgroup differences: Chi² = 0.23, df = 1 (P = 0.63), I² = 0%								

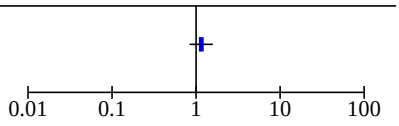


Footnotes

(1) HHS (higher scores indicate better function); HA1: cemented, modular, unipolar; HA2: uncemented, Moore, unipolar; at 3 months
(2) HHS (higher scores indicate better function); HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar at 3 months
(3) HHS (higher scores indicate better function); HA1: cemented, ecofit, bipolar; HA2: uncemented, modular, bipolar; at 6 weeks

Analysis 2.8. Comparison 2: HA: cemented vs uncemented, Outcome 8: Early functional status (≤ 4 months; categorical data)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Risk Ratio M-H, Fixed, 95% CI
Sonne-Holm 1982 (1)	29	40	22	35	1.15 [0.84 , 1.59]

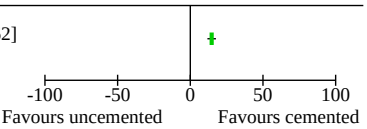


Footnotes

(1) D'Aubigne scale (proportion of participants with maximum scores); HA1: cemented, Moore, unipolar; HA2: uncemented, Moore, unipola

Analysis 2.9. Comparison 2: HA: cemented vs uncemented, Outcome 9: Early functional status: extracapsular fractures (≤ 4 months. HHS; higher scores indicate better function)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Mean Difference IV, Fixed, 95% CI
Cao 2017 (1)	75.55	7.36	43	60.85	6.34	42	14.70 [11.78 , 17.62]

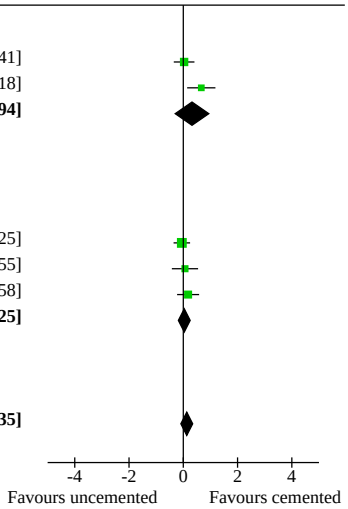


Footnotes

(1) HHS (higher scores indicate better function); HA1: cemented, stem type and uni/bipolar NR; HA2: uncemented, stem type and uni/bipolar NR; at 3 months

Analysis 2.10. Comparison 2: HA: cemented vs uncemented, Outcome 10: Functional status (12 months; continuous data using HHS, OHS and VELCA; higher scores indicate better function)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Weight	Std. Mean Difference IV, Random, 95% CI
2.10.1 First generation uncemented stem								
Santini 2005 (1)	9.13	6.02	53	8.95	5.86	53	21.8%	0.03 [-0.35 , 0.41]
Vidovic 2013 (2)	79.49	6.9	30	74.44	8.08	30	13.8%	0.66 [0.14 , 1.18]
Subtotal (95% CI)			**83**			**83**	**35.7%**	**0.32 [-0.30 , 0.94]**
Heterogeneity: Tau² = 0.15; Chi² = 3.70, df = 1 (P = 0.05); I² = 73%								
Test for overall effect: Z = 1.02 (P = 0.31)								
2.10.2 Modern stem								
Figved 2009 (3)	78.9	15.7	90	79.8	17.6	77	28.8%	-0.05 [-0.36 , 0.25]
Taylor 2012 (4)	33.4	6.4	29	33	6.4	38	15.5%	0.06 [-0.42 , 0.55]
Movrin 2020 (5)	81.2	9.5	45	79.6	8.4	49	20.0%	0.18 [-0.23 , 0.58]
Subtotal (95% CI)			**164**			**164**	**64.3%**	**0.04 [-0.18 , 0.25]**
Heterogeneity: Tau² = 0.00; Chi² = 0.81, df = 2 (P = 0.67); I² = 0%								
Test for overall effect: Z = 0.32 (P = 0.75)								
Total (95% CI)			**247**			**247**	**100.0%**	**0.13 [-0.09 , 0.35]**
Heterogeneity: Tau² = 0.02; Chi² = 5.77, df = 4 (P = 0.22); I² = 31%								
Test for overall effect: Z = 1.15 (P = 0.25)								
Test for subgroup differences: Chi² = 0.73, df = 1 (P = 0.39), I² = 0%								



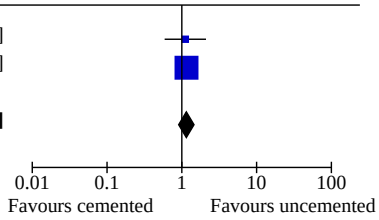
Footnotes

(1) Using VELCA (higher scores indicate better function). HA1: cemented, NR, unipolar; HA2: uncemented, NR, unipolar; at 12 months
(2) HHS (higher scores indicate better function). HA1: cemented, modular, unipolar; HA2: uncemented, Moore, unipolar; at 12 months
(3) HHS (higher scores indicate better function). HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar at 12 months
(4) OHS (higher scores indicate better function). HA1: cemented, Exeter, unipolar; HA2: uncemented, Zweymuller Alloclassic, unipolar; at 12 months
(5) HHS (higher scores indicate better function). HA1: cemented, ecofit, bipolar; HA2: uncemented, modular, bipolar; at 24 months

Analysis 2.11. Comparison 2: HA: cemented vs uncemented, Outcome 11: Functional status (12 months, categorical data using HHS)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
Sadr 1977 (1)	7	11	8	14	13.7%	1.11 [0.59 , 2.10]
Sonne-Holm 1982 (2)	33	40	25	35	86.3%	1.16 [0.90 , 1.49]
Total (95% CI)		**51**		**49**	**100.0%**	**1.15 [0.91 , 1.45]**
Total events:	40		33			

Heterogeneity: Tau² = 0.00; Chi² = 0.01, df = 1 (P = 0.92); I² = 0%
Test for overall effect: Z = 1.16 (P = 0.25)
Test for subgroup differences: Not applicable

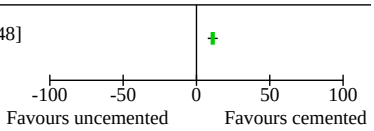


Footnotes

(1) Harris Hip Score (categorised as good or excellent). HA1: cemented, Thompson, unipolar; HA2: uncemented, Thompson, unipolar; at 17 months
(2) D'Aubigne scale (maximum scores); HA1: cemented, Moore, unipolar; HA2: uncemented, Moore, unipolar; at 12 months

Analysis 2.12. Comparison 2: HA: cemented vs uncemented, Outcome 12: Functional status: extracapsular fractures (12 months. HHS; higher scores indicate improved function)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Mean Difference IV, Fixed, 95% CI
Cao 2017 (1)	89.21	7.54	43	78.12	8.38	42	11.09 [7.70 , 14.48]

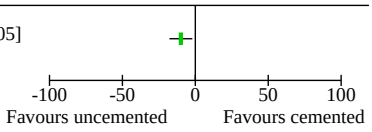


Footnotes

(1) HHS (higher scores indicate better function). HA1: cemented, stem type and uni/bipolar NR; HA2: uncemented, stem type and uni/bipolar NR; at 6 months

Analysis 2.13. Comparison 2: HA: cemented vs uncemented, Outcome 13: Late functional status (> 24 months using HHS; higher scores indicate better function)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Mean Difference IV, Fixed, 95% CI
Figved 2009 (1)	76.3	20.9	41	86.2	14.1	37	-9.90 [-17.75 , -2.05]



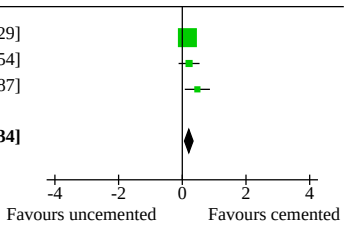
Footnotes

(1) HHS; HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 5 years

Analysis 2.14. Comparison 2: HA: cemented vs uncemented, Outcome 14: Early HRQoL (≤ 4 months)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Fernandez 2022 (1)	0.371	0.356	436	0.315	0.342	441	73.2%	0.16 [0.03 , 0.29]
Figved 2009 (2)	0.64	0.26	73	0.58	0.3	70	15.7%	0.21 [-0.12 , 0.54]
Moerman 2017 (3)	38.5	9.9	54	33.8	9.8	48	11.1%	0.47 [0.08 , 0.87]
Total (95% CI)			**563**			**559**	**100.0%**	**0.20 [0.07 , 0.34]**

Heterogeneity: Tau² = 0.00; Chi² = 2.19, df = 2 (P = 0.33); I² = 9%
Test for overall effect: Z = 2.96 (P = 0.003)
Test for subgroup differences: Not applicable

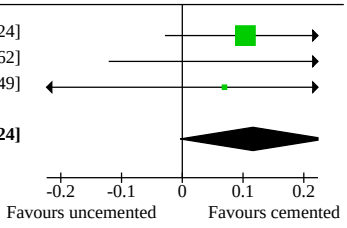


Footnotes
(1) EQ-5D (higher scores indicate better quality of life); using ITT data. HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at surgeons p
(2) EQ-5D (higher scores indicate better QoL). HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 3 months
(3) SF-12 (PCS: higher scores indicate better QoL). HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 3 months

Analysis 2.15. Comparison 2: HA: cemented vs uncemented, Outcome 15: HRQoL (12 months)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Fernandez 2022 (1)	0.329	0.349	438	0.293	0.343	438	81.3%	0.10 [-0.03 , 0.24]
Figved 2009 (2)	0.68	0.23	56	0.61	0.32	57	10.4%	0.25 [-0.12 , 0.62]
Moerman 2017 (3)	37.5	9.4	50	36.8	10.7	40	8.3%	0.07 [-0.35 , 0.49]
Total (95% CI)			**544**			**535**	**100.0%**	**0.12 [-0.00 , 0.24]**

Heterogeneity: Tau² = 0.00; Chi² = 0.58, df = 2 (P = 0.75); I² = 0%
Test for overall effect: Z = 1.91 (P = 0.06)
Test for subgroup differences: Not applicable

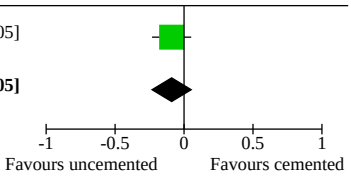


Footnotes
(1) EQ-5D (higher scores indicate better quality of life); using ITT data. HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at surgeons p
(2) EQ-5D (higher scores indicate better QoL). HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 12 months
(3) SF-12 (PCS: higher scores indicate better QoL). HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 12 months

Analysis 2.16. Comparison 2: HA: cemented vs uncemented, Outcome 16: Late HRQoL (> 24 months)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Figved 2009 (1)	0.64	0.35	35	0.73	0.25	36	100.0%	-0.09 [-0.23 , 0.05]
Total (95% CI)			**35**			**36**	**100.0%**	**-0.09 [-0.23 , 0.05]**

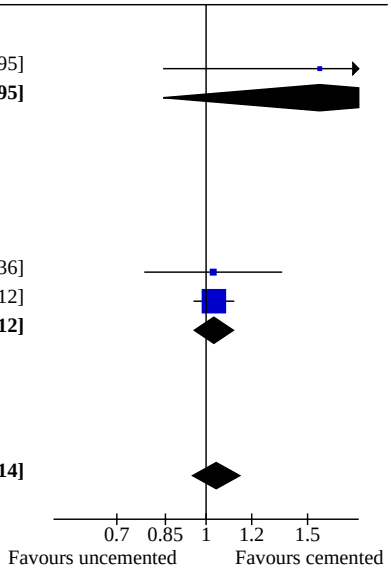
Heterogeneity: Not applicable
Test for overall effect: Z = 1.24 (P = 0.21)
Test for subgroup differences: Not applicable



Footnotes
(1) EQ-5D (higher scores indicate better quality of life); HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 5 years

Analysis 2.17. Comparison 2: HA: cemented vs uncemented, Outcome 17: Early mobility (≤ 4 months, independent mobility)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.17.1 First generation uncemented stem						
Sonne-Holm 1982 (1)	18	40	10	35	2.2%	1.57 [0.84 , 2.95]
Subtotal (95% CI)		**40**		**35**	**2.2%**	**1.58 [0.84 , 2.95]**
Total events:	18		10			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.42 (P = 0.15)						
2.17.2 Modern stem						
Fernandez 2022 (2)	82	366	76	349	11.2%	1.03 [0.78 , 1.36]
Figved 2009 (3)	94	100	82	90	86.6%	1.03 [0.95 , 1.12]
Subtotal (95% CI)		**466**		**439**	**97.8%**	**1.03 [0.95 , 1.12]**
Total events:	176		158			
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.97); I² = 0%						
Test for overall effect: Z = 0.78 (P = 0.44)						
Total (95% CI)		**506**		**474**	**100.0%**	**1.04 [0.95 , 1.14]**
Total events:	194		168			
Heterogeneity: Tau² = 0.00; Chi² = 2.10, df = 2 (P = 0.35); I² = 5%						
Test for overall effect: Z = 0.84 (P = 0.40)						
Test for subgroup differences: Chi² = 1.73, df = 1 (P = 0.19), I² = 42.2%						

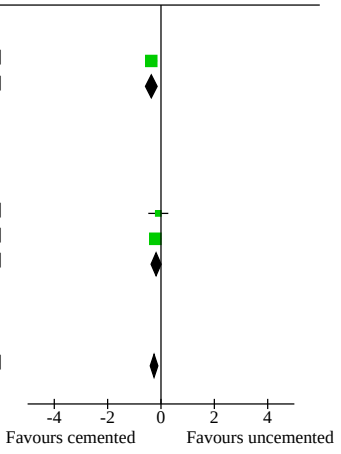


Footnotes

(1) Highest scores on d'Aubigne scale, mobility domain (indicates good mobility); HA1: cemented, Moore, unipolar; HA2: uncemented, Moore, unipolar; a
(2) Able to walk outdoors with ≤ 1 aid. HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at surgeons preference; at
(3) Able to walk independently using any aids; HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 3 months

Analysis 2.18. Comparison 2: HA: cemented vs uncemented, Outcome 18: Early mobility (≤ 4 months, continuous data)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Weight	Std. Mean Difference IV, Random, 95% CI
2.18.1 First generation uncemented stem								
Parker 2010c (1)	8.2	2.08	169	8.9	1.74	158	42.4%	-0.36 [-0.58 , -0.14]
Subtotal (95% CI)			**169**			**158**	**42.4%**	**-0.36 [-0.58 , -0.14]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 3.25 (P = 0.001)								
2.18.2 Modern stem								
Moerman 2017 (2)	-4.8	3.1	59	-4.5	2.8	51	14.4%	-0.10 [-0.48 , 0.27]
Parker 2020 (3)	5.7	1.98	164	6.1	1.78	165	43.2%	-0.21 [-0.43 , 0.00]
Subtotal (95% CI)			**223**			**216**	**57.6%**	**-0.18 [-0.37 , 0.00]**
Heterogeneity: Tau² = 0.00; Chi² = 0.25, df = 1 (P = 0.61); I² = 0%								
Test for overall effect: Z = 1.92 (P = 0.05)								
Total (95% CI)			**392**			**374**	**100.0%**	**-0.26 [-0.40 , -0.12]**
Heterogeneity: Tau² = 0.00; Chi² = 1.74, df = 2 (P = 0.42); I² = 0%								
Test for overall effect: Z = 3.58 (P = 0.0003)								
Test for subgroup differences: Chi² = 1.48, df = 1 (P = 0.22), I² = 32.6%								



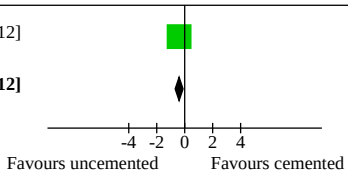
Footnotes

(1) Parker mobility scale (lower scores indicate better mobility). HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 3 months
(2) Mobility scale (scores range from 0 to 9; higher values indicate better mobility; data inverted in analysis). HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, l
(3) Parker mobility scale (higher scores indicate better mobility). HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 3 months

Analysis 2.19. Comparison 2: HA: cemented vs uncemented, Outcome 19: Early mobility (mean reduction values at ≤ 4 months; higher scores indicate better mobility)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Rehman 2014 (1)	2.8	0.755	55	3.2	0.755	55	100.0%	-0.40 [-0.68 , -0.12]
Total (95% CI)			**55**			**55**	**100.0%**	**-0.40 [-0.68 , -0.12]**

Heterogeneity: Not applicable
Test for overall effect: Z = 2.78 (P = 0.005)
Test for subgroup differences: Not applicable

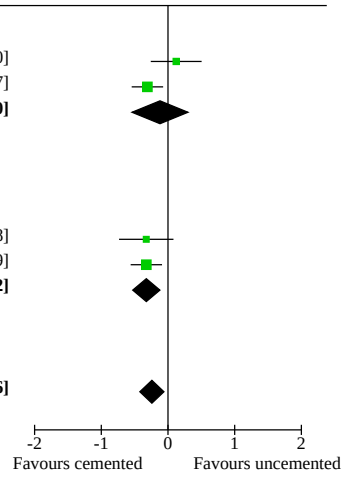


Footnotes

(1) Mean reduction in mobility (moblity scoring system). HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 12 weeks; using mobility scale (score

Analysis 2.20. Comparison 2: HA: cemented vs uncemented, Outcome 20: Mobility (12 months, continuous data using different mobility scales; lower scores indicate better mobility)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
2.20.1 First generation uncemented stem								
Santini 2005 (1)	-2.75	2.3	53	-3.03	2.22	53	17.4%	0.12 [-0.26 , 0.50]
Parker 2010c (2)	7.5	2.34	143	8.2	2.18	137	33.4%	-0.31 [-0.54 , -0.07]
Subtotal (95% CI)			**196**			**190**	**50.8%**	**-0.12 [-0.54 , 0.30]**
Heterogeneity: Tau² = 0.07; Chi² = 3.56, df = 1 (P = 0.06); I² = 72%								
Test for overall effect: Z = 0.56 (P = 0.58)								
2.20.2 Modern stem								
Moerman 2017 (3)	-5.7	2.9	50	-4.7	3.2	44	15.7%	-0.33 [-0.73 , 0.08]
Parker 2020 (4)	5.1	2.17	147	5.8	2.13	135	33.5%	-0.32 [-0.56 , -0.09]
Subtotal (95% CI)			**197**			**179**	**49.2%**	**-0.32 [-0.53 , -0.12]**
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 1.00); I² = 0%								
Test for overall effect: Z = 3.13 (P = 0.002)								
Total (95% CI)			**393**			**369**	**100.0%**	**-0.24 [-0.42 , -0.06]**
Heterogeneity: Tau² = 0.01; Chi² = 4.43, df = 3 (P = 0.22); I² = 32%								
Test for overall effect: Z = 2.62 (P = 0.009)								
Test for subgroup differences: Chi² = 0.74, df = 1 (P = 0.39), I² = 0%								

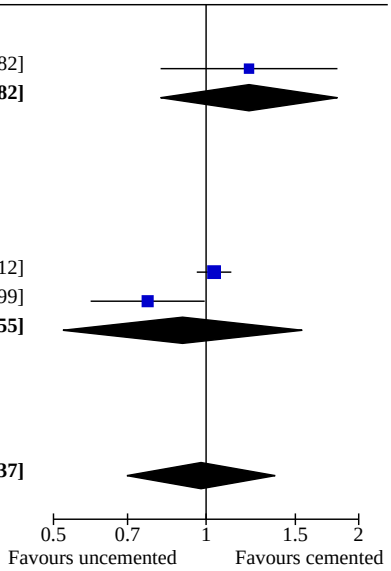


Footnotes

(1) Walking ability using VELCA functional scores (higher scores indicate more independent walking; we inverted the data in analysis). HA1: cemented, NR, unipolar; HA2: unce
(2) Mobility scale (lower scores indicate improved mobility). HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 12 months
(3) Mobility scale (higher scores indicate improved mobility; we inverted the data in analysis). HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR
(4) Mobility scale (lower scores indicate improved mobility). HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 12 months

Analysis 2.21. Comparison 2: HA: cemented vs uncemented, Outcome 21: Mobility (12 months, independent mobility)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.21.1 First generation uncemented stem						
Sonne-Holm 1982 (1)	25	40	18	35	26.1%	1.22 [0.81 , 1.82]
Subtotal (95% CI)		**40**		**35**	**26.1%**	**1.22 [0.81 , 1.82]**
Total events:	25		18			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.95 (P = 0.34)						
2.21.2 Modern						
Figved 2009 (2)	87	91	71	77	40.6%	1.04 [0.96 , 1.12]
Fernandez 2022 (3)	75	302	91	281	33.3%	0.77 [0.59 , 0.99]
Subtotal (95% CI)		**393**		**358**	**73.9%**	**0.90 [0.52 , 1.55]**
Total events:	162		162			
Heterogeneity: Tau² = 0.14; Chi² = 16.18, df = 1 (P < 0.0001); I² = 94%						
Test for overall effect: Z = 0.39 (P = 0.70)						
Total (95% CI)		**433**		**393**	**100.0%**	**0.98 [0.70 , 1.37]**
Total events:	187		180			
Heterogeneity: Tau² = 0.07; Chi² = 12.49, df = 2 (P = 0.002); I² = 84%						
Test for overall effect: Z = 0.13 (P = 0.89)						
Test for subgroup differences: Chi² = 0.77, df = 1 (P = 0.38), I² = 0%						



Footnotes

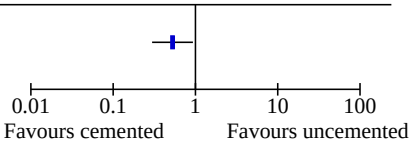
(1) Aubigne scale, mobility domain; HA1: cemented, Moore, unipolar; HA2: uncemented, Moore, unipolar; at 12 months

(2) Able to walk independently using any aids; HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 12 months

(3) Able to walk outdoors with ≤ 1 aid; HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at surgeons preference; at

Analysis 2.22. Comparison 2: HA: cemented vs uncemented, Outcome 22: Mobility (12 months, dependent on walking aid)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Risk Ratio M-H, Fixed, 95% CI
Emery 1991 (1)	8	19	16	20	0.53 [0.30 , 0.93]

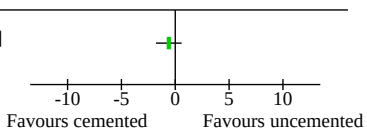


Footnotes

(1) More dependent on walking aids than before injury; HA1: cemented, Thompson, bipolar; HA2: uncemented, Moore, bipolar; at 17 and 18 m

Analysis 2.23. Comparison 2: HA: cemented vs uncemented, Outcome 23: Late mobility (> 24 months)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Mean Difference IV, Fixed, 95% CI
Parker 2010c (1)	7.3	2.63	29	7.9	2.15	35	-0.60 [-1.79 , 0.59]



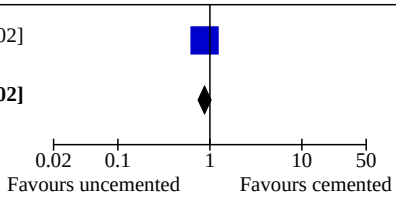
Footnotes

(1) Mobility scale (lower scores indicate improved mobility). HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 60 months

Analysis 2.24. Comparison 2: HA: cemented vs uncemented, Outcome 24: Late mobility (> 24 months; independent mobility)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Figved 2009 (1)	34	41	36	38	100.0%	0.88 [0.75 , 1.02]
Total (95% CI)		**41**		**38**	**100.0%**	**0.88 [0.75 , 1.02]**
Total events:	34		36			

Heterogeneity: Not applicable
Test for overall effect: Z = 1.65 (P = 0.10)
Test for subgroup differences: Not applicable

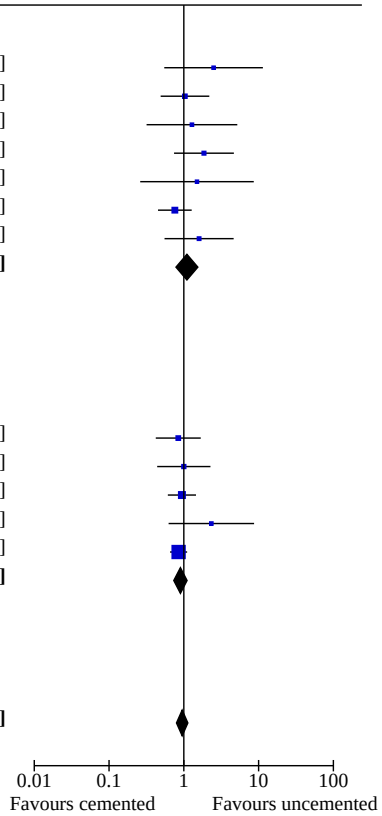


Footnotes

(1) Reported as being able to walk independently using any aids; HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 6 years

Analysis 2.25. Comparison 2: HA: cemented vs uncemented, Outcome 25: Early mortality (≤ 4 months)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.25.1 First generation uncemented stem						
Sadr 1977 (1)	5	20	2	20	1.3%	2.50 [0.55 , 11.41]
Sonne-Holm 1982 (2)	11	55	11	57	5.4%	1.04 [0.49 , 2.19]
Emery 1991 (3)	4	27	3	26	1.6%	1.28 [0.32 , 5.19]
Harper 1994 (4)	12	71	6	66	3.6%	1.86 [0.74 , 4.67]
Santini 2005 (5)	3	53	2	53	1.0%	1.50 [0.26 , 8.62]
Parker 2010c (6)	22	200	29	200	11.3%	0.76 [0.45 , 1.27]
DeAngelis 2012 (7)	8	66	5	66	2.7%	1.60 [0.55 , 4.64]
Subtotal (95% CI)		**492**		**488**	**26.9%**	**1.10 [0.79 , 1.54]**
Total events:	65		58			
Heterogeneity: Tau² = 0.00; Chi² = 5.02, df = 6 (P = 0.54); I² = 0%						
Test for overall effect: Z = 0.55 (P = 0.58)						
2.25.2 Modern stem						
Figved 2009 (8)	13	108	15	105	6.4%	0.84 [0.42 , 1.68]
Taylor 2012 (9)	10	80	10	80	4.5%	1.00 [0.44 , 2.27]
Parker 2020 (10)	33	200	35	200	16.2%	0.94 [0.61 , 1.45]
Movrin 2020 (11)	7	79	3	79	1.8%	2.33 [0.63 , 8.70]
Fernandez 2022	87	610	103	615	44.2%	0.85 [0.65 , 1.11]
Subtotal (95% CI)		**1077**		**1079**	**73.1%**	**0.90 [0.73 , 1.10]**
Total events:	150		166			
Heterogeneity: Tau² = 0.00; Chi² = 2.33, df = 4 (P = 0.68); I² = 0%						
Test for overall effect: Z = 1.01 (P = 0.31)						
Total (95% CI)		**1569**		**1567**	**100.0%**	**0.95 [0.80 , 1.13]**
Total events:	215		224			
Heterogeneity: Tau² = 0.00; Chi² = 8.34, df = 11 (P = 0.68); I² = 0%						
Test for overall effect: Z = 0.57 (P = 0.57)						
Test for subgroup differences: Chi² = 0.99, df = 1 (P = 0.32), I² = 0%						

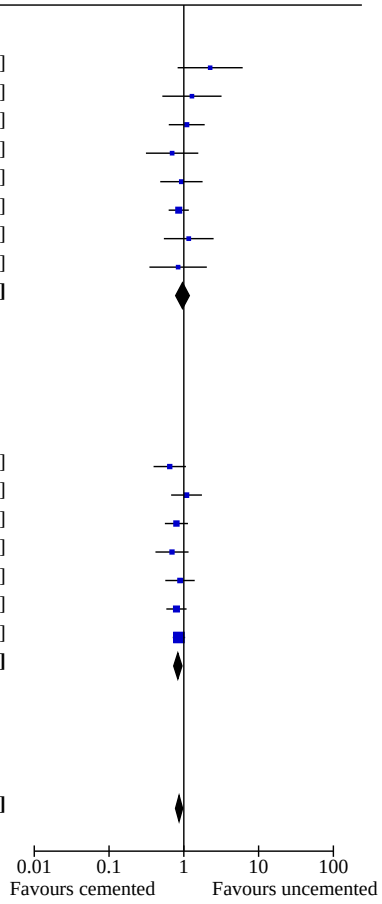


Footnotes

(1) HA1: cemented, Thompson, unipolar; HA2: uncemented, Thompson, unipolar; at 6 weeks
(2) HA1: cemented, Moore, unipolar; HA2: uncemented, Moore, unipolar; at 6 weeks
(3) HA1: cemented, Thompson, bipolar; HA2: uncemented, Moore, bipolar; at 3 months
(4) HA1: cemented, Thompson, unipolar; HA2: uncemented, Thompson, unipolar; at 3 months
(5) HA1: cemented, NR, unipolar; HA2: uncemented, NR, unipolar; at hospital discharge
(6) HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 2 to 3 months
(7) HA1: cemented, VerSys stem, unipolar; HA2: uncemented, beaded stem, unipolar; at 3 months
(8) HA1: cemented, Spectron, bipolar; HA2: uncemented, Corail, bipolar; at 3 months
(9) HA1: cemented, Exeter, unipolar; HA2: uncemented, Zweymuller Alloclassic, unipolar; at 6 weeks
(10) HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 4 months
(11) HA1: cemented, ecofit, bipolar; HA2: uncemented, modular, bipolar; at 7 days

Analysis 2.26. Comparison 2: HA: cemented vs uncemented, Outcome 26: Mortality (12 months)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.26.1 First generation uncemented stem						
Sadr 1977 (1)	9	20	4	20	1.2%	2.25 [0.83 , 6.13]
Emery 1991 (2)	8	27	6	26	1.4%	1.28 [0.52 , 3.19]
Harper 1994 (1)	20	71	17	66	3.8%	1.09 [0.63 , 1.90]
Brandfoot 2000 (3)	7	38	14	53	1.8%	0.70 [0.31 , 1.56]
Santini 2005 (4)	13	53	14	53	2.7%	0.93 [0.48 , 1.78]
Parker 2010c (5)	53	200	62	200	12.1%	0.85 [0.63 , 1.17]
DeAngelis 2012 (6)	12	66	10	64	2.0%	1.16 [0.54 , 2.50]
Vidovic 2013 (7)	7	38	9	41	1.5%	0.84 [0.35 , 2.03]
Subtotal (95% CI)		**513**		**523**	**26.5%**	**0.96 [0.78 , 1.18]**
Total events:	129		136			
Heterogeneity: Tau² = 0.00; Chi² = 4.87, df = 7 (P = 0.68); I² = 0%						
Test for overall effect: Z = 0.38 (P = 0.70)						
2.26.2 Modern stem						
Figved 2009 (8)	20	108	30	105	4.7%	0.65 [0.39 , 1.07]
Taylor 2012 (9)	25	80	23	80	5.2%	1.09 [0.68 , 1.75]
Talsnes 2013 (10)	39	162	52	172	9.2%	0.80 [0.56 , 1.14]
Moerman 2017 (11)	21	110	25	91	4.5%	0.69 [0.42 , 1.16]
Movrin 2020 (12)	24	79	27	79	5.7%	0.89 [0.57 , 1.40]
Parker 2020 (13)	51	200	64	200	12.0%	0.80 [0.58 , 1.09]
Fernandez 2022 (14)	146	610	171	615	32.2%	0.86 [0.71 , 1.04]
Subtotal (95% CI)		**1349**		**1342**	**73.5%**	**0.83 [0.73 , 0.94]**
Total events:	326		392			
Heterogeneity: Tau² = 0.00; Chi² = 3.01, df = 6 (P = 0.81); I² = 0%						
Test for overall effect: Z = 2.87 (P = 0.004)						
Total (95% CI)		**1862**		**1865**	**100.0%**	**0.86 [0.78 , 0.96]**
Total events:	455		528			
Heterogeneity: Tau² = 0.00; Chi² = 9.20, df = 14 (P = 0.82); I² = 0%						
Test for overall effect: Z = 2.66 (P = 0.008)						
Test for subgroup differences: Chi² = 1.33, df = 1 (P = 0.25), I² = 24.8%						



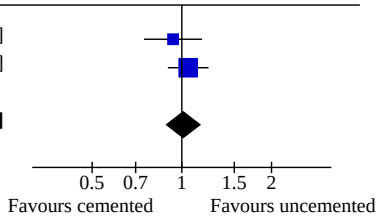
Footnotes

(1) HA1: cemented, Thompson, unipolar; HA2: uncemented, Thompson, unipolar; at 12 months
(2) HA1: cemented, Thompson, bipolar; HA2: uncemented, Moore, bipolar; at 17/18 months respectively
(3) HA1: cemented, Thompson, unipolar; HA2: uncemented Thompson, unipolar; at 16 months
(4) HA1: cemented, NR, unipolar; HA2: uncemented, NR, unipolar; at 12 months
(5) HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 12 months
(6) HA1: cemented, VerSys stem, unipolar; HA2: uncemented, beaded stem, unipolar; at 12 months
(7) HA1: cemented, modular, unipolar; HA2: uncemented, Moore, unipolar; at 12 months
(8) HA1: cemented, Spectron, bipolar; HA2: uncemented, Corail, bipolar; at 12 months
(9) HA1: cemented, Exeter, unipolar; HA2: uncemented, Zweymuller Alloclassic, unipolar; at 12 months
(10) HA1: cemented, Landos titan, bipolar; HA2: uncemented, Landos corail, bipolar; at 12 months
(11) HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 12 months
(12) HA1: cemented, ecofit, bipolar; HA2: uncemented, modular, bipolar; at 24 months
(13) HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 12 months
(14) Using ITT analysis; HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at surgeons preference; at 12 months

Analysis 2.27. Comparison 2: HA: cemented vs uncemented, Outcome 27: Late mortality (> 24 months)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
Figved 2009 (1)	63	112	65	108	32.9%	0.93 [0.75 , 1.17]
Parker 2010c (2)	125	200	119	200	67.1%	1.05 [0.90 , 1.23]
Total (95% CI)		**312**		**308**	**100.0%**	**1.01 [0.89 , 1.15]**
Total events:	188		184			

Heterogeneity: Tau² = 0.00; Chi² = 0.70, df = 1 (P = 0.40); I² = 0%
Test for overall effect: Z = 0.16 (P = 0.87)
Test for subgroup differences: Not applicable

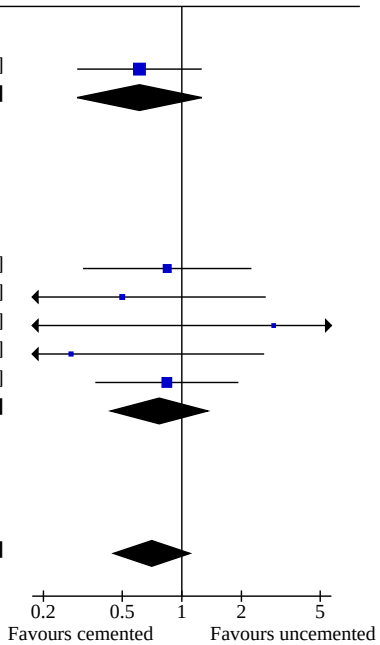


Footnotes
(1) HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 60 months
(2) HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 60 months

Analysis 2.28. Comparison 2: HA: cemented vs uncemented, Outcome 28: Unplanned return to theatre (end of follow-up)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.28.1 First generation uncemented stem						
Parker 2010c (1)	11	200	18	200	37.8%	0.61 [0.30 , 1.26]
Subtotal (95% CI)		**200**		**200**	**37.8%**	**0.61 [0.30 , 1.26]**
Total events:	11		18			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.33 (P = 0.18)						
2.28.2 Modern stem						
Figved 2009 (2)	7	112	8	108	20.6%	0.84 [0.32 , 2.25]
Taylor 2012 (3)	2	80	4	80	7.1%	0.50 [0.09 , 2.65]
DeAngelis 2012 (4)	1	66	0	64	2.0%	2.91 [0.12 , 70.15]
Moerman 2017 (5)	1	110	3	91	3.9%	0.28 [0.03 , 2.61]
Fernandez 2022 (6)	10	610	12	615	28.6%	0.84 [0.37 , 1.93]
Subtotal (95% CI)		**978**		**958**	**62.2%**	**0.77 [0.44 , 1.35]**
Total events:	21		27			
Heterogeneity: Tau² = 0.00; Chi² = 1.81, df = 4 (P = 0.77); I² = 0%						
Test for overall effect: Z = 0.91 (P = 0.36)						
Total (95% CI)		**1178**		**1158**	**100.0%**	**0.70 [0.45 , 1.10]**
Total events:	32		45			

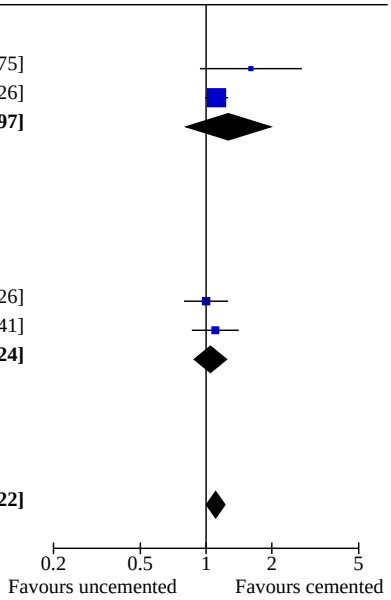
Heterogeneity: Tau² = 0.00; Chi² = 2.05, df = 5 (P = 0.84); I² = 0%
Test for overall effect: Z = 1.54 (P = 0.12)
Test for subgroup differences: Chi² = 0.24, df = 1 (P = 0.62), I² = 0%



Footnotes
(1) HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 60 months
(2) HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 12 months
(3) HA1: cemented, Exeter, unipolar; HA2: uncemented, Zweymuller Alloclassic, unipolar; at 24 months
(4) HA1: cemented, VerSys stem, unipolar; HA2: uncemented, beaded stem, unipolar; at 12 months
(5) HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 12 months
(6) HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at surgeons preference; at 12 months

Analysis 2.29. Comparison 2: HA: cemented vs uncemented, Outcome 29: Early pain (≤ 4 months, experiencing no pain)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.29.1 First generation uncemented stem						
Sonne-Holm 1982 (1)	22	40	12	35	3.3%	1.60 [0.94 , 2.75]
Harper 1994 (2)	56	59	51	60	63.8%	1.12 [0.99 , 1.26]
Subtotal (95% CI)		**99**		**95**	**67.1%**	**1.26 [0.81 , 1.97]**
Total events:	78		63			
Heterogeneity: Tau² = 0.07; Chi² = 2.88, df = 1 (P = 0.09); I² = 65%						
Test for overall effect: Z = 1.04 (P = 0.30)						
2.29.2 Modern stem						
Figved 2009 (3)	60	100	54	90	17.5%	1.00 [0.79 , 1.26]
Moerman 2017 (4)	44	61	36	55	15.4%	1.10 [0.86 , 1.41]
Subtotal (95% CI)		**161**		**145**	**32.9%**	**1.05 [0.88 , 1.24]**
Total events:	104		90			
Heterogeneity: Tau² = 0.00; Chi² = 0.32, df = 1 (P = 0.57); I² = 0%						
Test for overall effect: Z = 0.53 (P = 0.60)						
Total (95% CI)		**260**		**240**	**100.0%**	**1.11 [1.00 , 1.22]**
Total events:	182		153			
Heterogeneity: Tau² = 0.00; Chi² = 2.59, df = 3 (P = 0.46); I² = 0%						
Test for overall effect: Z = 2.03 (P = 0.04)						
Test for subgroup differences: Chi² = 0.61, df = 1 (P = 0.44), I² = 0%						



Footnotes

(1) D'Aubigne scale, pain domain (experiencing no pain); HA1: cemented, Moore, unipolar; HA2: uncemented, Moore, unipolar; at 12 months

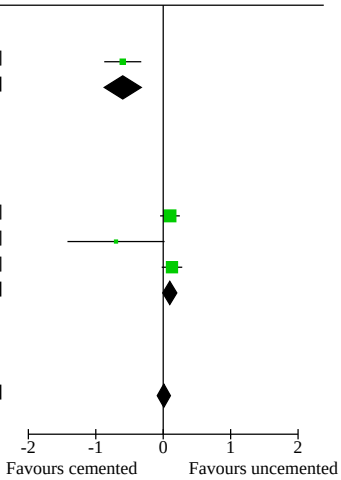
(2) Participants complaining of pain (we inverted data this data to indicate no pain); HA1: cemented, Thompson, unipolar; HA2: uncemented, Thompson, u

(3) Not in need of pain medication; HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 3 months

(4) Mid thigh pain (we inverted this data to indicate no pain); HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 3 mont

Analysis 2.30. Comparison 2: HA: cemented vs uncemented, Outcome 30: Early pain (≤ 4 months; mean scores, lower scores indicate less pain)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
2.30.1 First generation uncemented stem								
Parker 2010c (1)	1.9	1.2	164	2.5	1.3	156	12.6%	-0.60 [-0.87 , -0.33]
Subtotal (95% CI)			**164**			**156**	**12.6%**	**-0.60 [-0.87 , -0.33]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 4.28 (P < 0.0001)								
2.30.2 Modern stem								
Parker 2020 (2)	1.4	0.58	164	1.3	0.75	160	44.5%	0.10 [-0.05 , 0.25]
Movrin 2020 (3)	4.7	2.1	79	5.4	2.5	79	1.8%	-0.70 [-1.42 , 0.02]
Fernandez 2022 (4)	-1.92	1.02	360	-2.05	1.04	345	41.1%	0.13 [-0.02 , 0.28]
Subtotal (95% CI)			**603**			**584**	**87.4%**	**0.10 [-0.01 , 0.20]**
Heterogeneity: Chi² = 4.89, df = 2 (P = 0.09); I² = 59%								
Test for overall effect: Z = 1.83 (P = 0.07)								
Total (95% CI)			**767**			**740**	**100.0%**	**0.01 [-0.09 , 0.11]**
Heterogeneity: Chi² = 26.55, df = 3 (P < 0.00001); I² = 89%								
Test for overall effect: Z = 0.19 (P = 0.85)								
Test for subgroup differences: Chi² = 21.66, df = 1 (P < 0.00001), I² = 95.4%								



Footnotes

(1) VAS (lower scores indicate less pain). HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 3 months

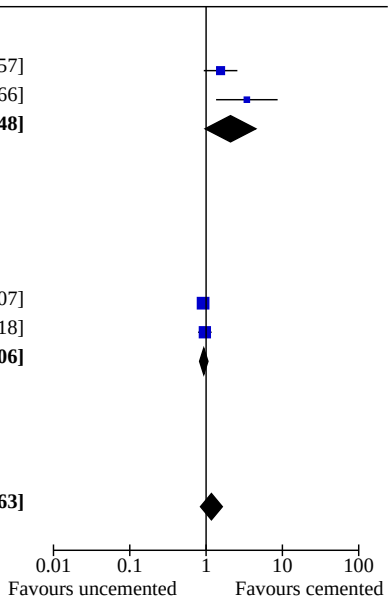
(2) Pain scale (lower scores indicate less pain). HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 3 months

(3) VAS (lower scores indicate less pain). HA1: cemented, ecofit, bipolar; HA2: uncemented, modular, bipolar; at 6 weeks

(4) Derived from EQ-5D utility index, using 5-point Likert scale (higher scores indicate more pain; we inverted data in the analysis); HA1: cemented, stem and head at surgeons

Analysis 2.31. Comparison 2: HA: cemented vs uncemented, Outcome 31: Pain (12 months, experiencing no pain)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.31.1 First generation uncemented stem						
Sonne-Holm 1982 (1)	23	40	13	35	20.3%	1.55 [0.93 , 2.57]
Emery 1991 (2)	13	19	4	20	9.5%	3.42 [1.35 , 8.66]
Subtotal (95% CI)		**59**		**55**	**29.8%**	**2.09 [0.97 , 4.48]**
Total events:	36		17			
Heterogeneity: Tau² = 0.18; Chi² = 2.22, df = 1 (P = 0.14); I² = 55%						
Test for overall effect: Z = 1.89 (P = 0.06)						
2.31.2 Modern stem						
Figved 2009 (3)	68	91	63	77	36.0%	0.91 [0.78 , 1.07]
Moerman 2017 (4)	40	51	35	43	34.2%	0.96 [0.79 , 1.18]
Subtotal (95% CI)		**142**		**120**	**70.2%**	**0.93 [0.82 , 1.06]**
Total events:	108		98			
Heterogeneity: Tau² = 0.00; Chi² = 0.17, df = 1 (P = 0.68); I² = 0%						
Test for overall effect: Z = 1.10 (P = 0.27)						
Total (95% CI)		**201**		**175**	**100.0%**	**1.17 [0.85 , 1.63]**
Total events:	144		115			
Heterogeneity: Tau² = 0.07; Chi² = 13.27, df = 3 (P = 0.004); I² = 77%						
Test for overall effect: Z = 0.96 (P = 0.34)						
Test for subgroup differences: Chi² = 4.18, df = 1 (P = 0.04), I² = 76.1%						



Footnotes

(1) D'Aubigne scale, pain domain (experiencing no pain); HA1: cemented, Moore, unipolar; HA2: uncemented, Moore, unipolar; at 12 months

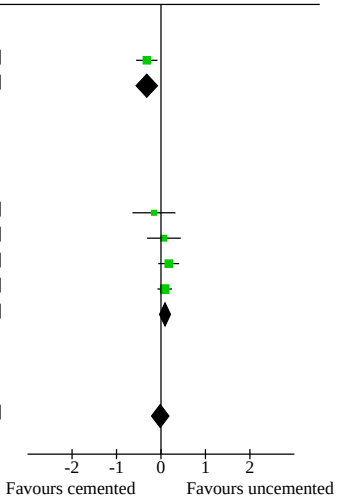
(2) Participants with no pain; HA1: cemented, Thompson, bipolar; HA2: uncemented, Moore, bipolar; at 17/18 months respectively

(3) Participants with no pain (require no analgesics); HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 12 months

(4) Mid-thigh pain (we inverted this data to indicate no pain); HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 12 moı

Analysis 2.32. Comparison 2: HA: cemented vs uncemented, Outcome 32: Pain (12 months, using continuous data; lower values indicate less pain)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
2.32.1 First generation uncemented stem								
Parker 2010c (1)	1.8	1.2	141	2.2	1.3	131	22.8%	-0.32 [-0.56 , -0.08]
Subtotal (95% CI)			**141**			**131**	**22.8%**	**-0.32 [-0.56 , -0.08]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 2.61 (P = 0.009)								
2.32.2 Modern stem								
Taylor 2012 (2)	2.3	2.3	29	2.67	2.3	38	11.1%	-0.16 [-0.64 , 0.33]
Movrin 2020 (3)	3.4	1.6	55	3.3	1.4	52	15.0%	0.07 [-0.31 , 0.45]
Parker 2020 (4)	1.2	0.59	146	1.1	0.55	134	23.1%	0.17 [-0.06 , 0.41]
Fernandez 2022 (5)	-1.76	0.92	300	-1.84	0.99	279	28.0%	0.08 [-0.08 , 0.25]
Subtotal (95% CI)			**530**			**503**	**77.2%**	**0.09 [-0.03 , 0.21]**
Heterogeneity: Tau² = 0.00; Chi² = 1.54, df = 3 (P = 0.67); I² = 0%								
Test for overall effect: Z = 1.46 (P = 0.14)								
Total (95% CI)			**671**			**634**	**100.0%**	**-0.02 [-0.21 , 0.18]**
Heterogeneity: Tau² = 0.03; Chi² = 10.49, df = 4 (P = 0.03); I² = 62%								
Test for overall effect: Z = 0.17 (P = 0.87)								
Test for subgroup differences: Chi² = 8.95, df = 1 (P = 0.003), I² = 88.8%								

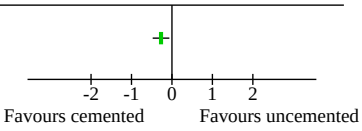


Footnotes

(1) VAS (lower scores indicate less pain). HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 12 months
(2) VAS (lower scores indicate less pain). HA1: cemented, Exeter, unipolar; HA2: uncemented, Zweymuller Alloclassic, unipolar; at 12 months
(3) VAS (lower scores indicate less pain). HA1: cemented, ecofit, bipolar; HA2: uncemented, modular, bipolar; at 6 months
(4) Pain scale (lower scores indicate less pain). HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 12 months
(5) Derived from EQ-5D utility index, using 5-point Likert scale (higher scores indicate less pain; we inverted data in the analysis); HA1: cemented, stem and head at surgeons pre

Analysis 2.33. Comparison 2: HA: cemented vs uncemented, Outcome 33: Pain (12 months; mean reduction values: lower scores indicate less pain)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
Rehman 2014 (1)	2.73	0.449	55	3	0.638	55	-0.27 [-0.48 , -0.06]

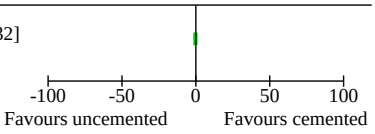


Footnotes

(1) Pain using 6 point scale (lower scores indicate less pain); HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 12 months

Analysis 2.34. Comparison 2: HA: cemented vs uncemented, Outcome 34: Late pain (> 24 months, using mean scores; lower scores indicate less pain)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
Parker 2010c (1)	1.7	1.1	26	2	1.3	32	-0.30 [-0.92 , 0.32]



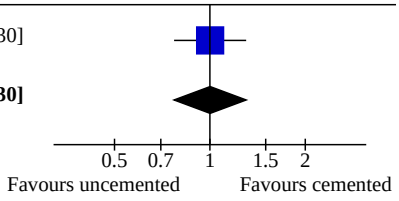
Footnotes

(1) VAS (lower scores indicate less pain). HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 5 years

Analysis 2.35. Comparison 2: HA: cemented vs uncemented, Outcome 35: Late pain (> 24 months; experiencing no pain)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Figved 2009 (1)	31	42	28	38	100.0%	1.00 [0.77 , 1.30]
Total (95% CI)		**42**		**38**	**100.0%**	**1.00 [0.77 , 1.30]**
Total events:	31		28			

Heterogeneity: Not applicable
Test for overall effect: Z = 0.01 (P = 0.99)
Test for subgroup differences: Not applicable

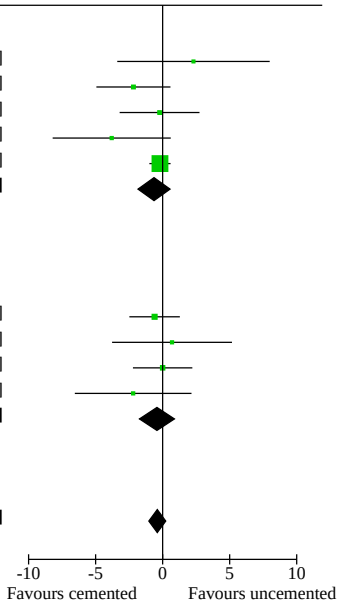


Footnotes

(1) Not in need of pain medication; HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 5 years

Analysis 2.36. Comparison 2: HA: cemented vs uncemented, Outcome 36: Length of hospital stay (days)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Weight	Mean Difference IV, Random, 95% CI
2.36.1 First generation uncemented stem								
Emery 1991 (1)	21.8	11.7	25	19.5	8.4	24	1.2%	2.30 [-3.39 , 7.99]
Harper 1994 (2)	14.38	9.54	67	16.56	6.34	64	5.2%	-2.18 [-4.94 , 0.58]
Santini 2005 (3)	17.23	9.1	53	17.46	6.29	53	4.5%	-0.23 [-3.21 , 2.75]
Parker 2010c (4)	18.8	21.4	200	22.6	23.5	200	2.0%	-3.80 [-8.20 , 0.60]
Vidovic 2013 (5)	7.82	1.85	38	8.02	1.72	41	63.7%	-0.20 [-0.99 , 0.59]
Subtotal (95% CI)			**383**			**382**	**76.6%**	**-0.64 [-1.84 , 0.55]**
Heterogeneity: Tau² = 0.45; Chi² = 5.01, df = 4 (P = 0.29); I² = 20%								
Test for overall effect: Z = 1.06 (P = 0.29)								
2.36.2 Modern stem								
Figved 2009 (6)	7.8	4.11	109	8.4	9.02	106	11.2%	-0.60 [-2.48 , 1.28]
Taylor 2012 (7)	27.2	14.6	80	26.5	14.26	80	2.0%	0.70 [-3.77 , 5.17]
Moerman 2017 (8)	11	8.3	110	11	7.7	91	8.1%	0.00 [-2.22 , 2.22]
Parker 2020 (9)	21.1	22.1	200	23.3	22.3	200	2.1%	-2.20 [-6.55 , 2.15]
Subtotal (95% CI)			**499**			**477**	**23.4%**	**-0.43 [-1.73 , 0.88]**
Heterogeneity: Tau² = 0.00; Chi² = 1.06, df = 3 (P = 0.79); I² = 0%								
Test for overall effect: Z = 0.64 (P = 0.52)								
Total (95% CI)			**882**			**859**	**100.0%**	**-0.40 [-1.03 , 0.23]**
Heterogeneity: Tau² = 0.00; Chi² = 6.07, df = 8 (P = 0.64); I² = 0%								
Test for overall effect: Z = 1.24 (P = 0.21)								
Test for subgroup differences: Chi² = 0.06, df = 1 (P = 0.81), I² = 0%								

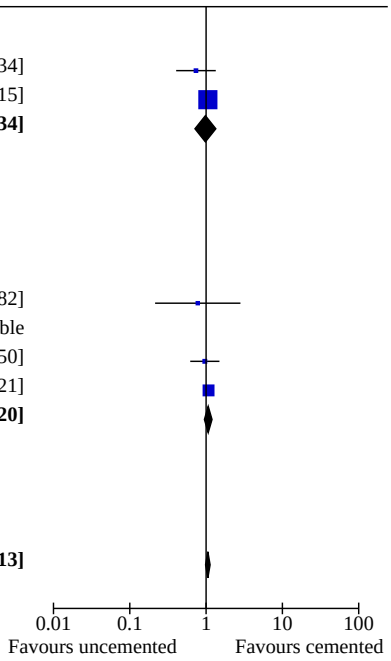


Footnotes

(1) HA1: cemented, Thompson, bipolar; HA2: uncemented, Moore, bipolar
(2) HA1: cemented, Thompson, unipolar; HA2: uncemented, Thompson, unipolar
(3) HA1: cemented, NR, unipolar; HA2: uncemented, NR, unipolar
(4) HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar
(5) HA1: cemented, modular, unipolar; HA2: uncemented, Moore, unipolar
(6) HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar
(7) HA1: cemented, Exeter, unipolar; HA2: uncemented, Zweymuller Alloclassic, unipolar
(8) HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR
(9) HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar

Analysis 2.37. Comparison 2: HA: cemented vs uncemented, Outcome 37: Discharge destination (own home)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.37.1 First generation uncemented stem						
Santini 2005 (1)	13	50	18	51	1.3%	0.74 [0.41 , 1.34]
Parker 2010c (2)	173	200	164	200	63.6%	1.05 [0.97 , 1.15]
Subtotal (95% CI)		**250**		**251**	**64.9%**	**0.98 [0.71 , 1.34]**
Total events:	186		182			
Heterogeneity: Tau² = 0.03; Chi² = 1.65, df = 1 (P = 0.20); I² = 39%						
Test for overall effect: Z = 0.13 (P = 0.89)						
2.37.2 Modern stem						
Figved 2009 (3)	4	109	5	106	0.3%	0.78 [0.21 , 2.82]
DeAngelis 2012 (4)	0	66	0	64		Not estimable
Taylor 2012 (5)	26	80	27	80	2.4%	0.96 [0.62 , 1.50]
Fernandez 2022 (6)	298	610	279	615	32.5%	1.08 [0.96 , 1.21]
Subtotal (95% CI)		**865**		**865**	**35.1%**	**1.07 [0.95 , 1.20]**
Total events:	328		311			
Heterogeneity: Tau² = 0.00; Chi² = 0.47, df = 2 (P = 0.79); I² = 0%						
Test for overall effect: Z = 1.10 (P = 0.27)						
Total (95% CI)		**1115**		**1116**	**100.0%**	**1.05 [0.98 , 1.13]**
Total events:	514		493			
Heterogeneity: Tau² = 0.00; Chi² = 1.91, df = 4 (P = 0.75); I² = 0%						
Test for overall effect: Z = 1.52 (P = 0.13)						
Test for subgroup differences: Chi² = 0.25, df = 1 (P = 0.62), I² = 0%						



Footnotes

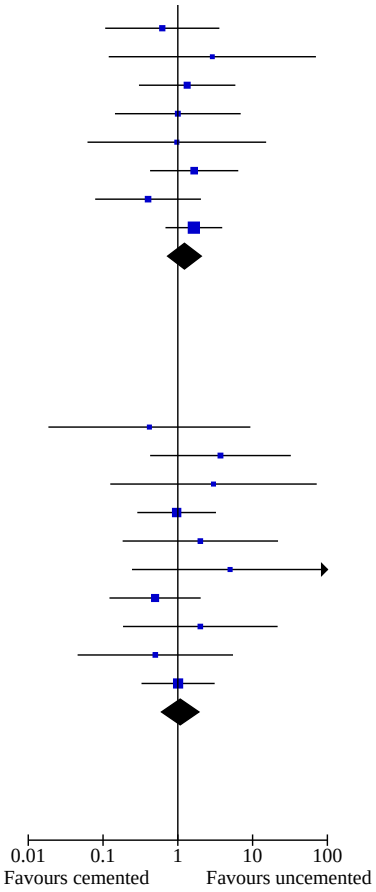
(1) HA1: cemented, NR, unipolar; HA2: uncemented, NR, unipolar
(2) HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar
(3) Reported as return to own home at discharge but reversed to correct direction of effect number report those not in own home. HA1: cemented, Spectron,
(4) HA1: cemented, VerSys stem, unipolar; HA2: uncemented, beaded stem, unipolar
(5) HA1: cemented, Exeter, unipolar; HA2: uncemented, Zweymuller Alloclassic, unipolar
(6) HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at surgeons preference

Analysis 2.38. Comparison 2: HA: cemented vs uncemented, Outcome 38: Adverse events related to the implant, fracture, or both

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.38.1 Intraoperative periprosthetic fracture						
Figved 2009 (1)	1	112	2	108	11.5%	0.48 [0.04 , 5.24]
Parker 2010c (2)	0	200	14	200	8.5%	0.03 [0.00 , 0.57]
DeAngelis 2012 (3)	2	66	3	64	20.0%	0.65 [0.11 , 3.74]
Taylor 2012 (4)	0	80	6	80	8.2%	0.08 [0.00 , 1.34]
Moerman 2017 (5)	0	110	12	91	8.5%	0.03 [0.00 , 0.55]
Movrin 2020 (6)	0	79	2	79	7.4%	0.20 [0.01 , 4.10]
Parker 2020 (7)	3	200	14	200	35.9%	0.21 [0.06 , 0.73]
Subtotal (95% CI)		**847**		**822**	**100.0%**	**0.20 [0.08 , 0.46]**
Total events:	6		53			
Heterogeneity: Tau² = 0.12; Chi² = 6.57, df = 6 (P = 0.36); I² = 9%						
Test for overall effect: Z = 3.79 (P = 0.0002)						
2.38.2 Postoperative periprosthetic fracture						
Santini 2005 (8)	0	53	2	53	5.2%	0.20 [0.01 , 4.07]
Figved 2009 (1)	1	112	4	108	10.0%	0.24 [0.03 , 2.12]
Parker 2010c (2)	0	200	3	200	5.4%	0.14 [0.01 , 2.75]
Taylor 2012 (4)	1	80	12	80	11.6%	0.08 [0.01 , 0.63]
Moerman 2017 (5)	3	110	2	91	15.1%	1.24 [0.21 , 7.27]
Movrin 2020 (6)	0	55	1	52	4.7%	0.32 [0.01 , 7.57]
Parker 2020 (7)	2	200	5	200	17.8%	0.40 [0.08 , 2.04]
Fernandez 2022 (9)	3	610	13	615	30.2%	0.23 [0.07 , 0.81]
Subtotal (95% CI)		**1420**		**1399**	**100.0%**	**0.29 [0.14 , 0.57]**
Total events:	10		42			
Heterogeneity: Tau² = 0.00; Chi² = 4.76, df = 7 (P = 0.69); I² = 0%						
Test for overall effect: Z = 3.55 (P = 0.0004)						
2.38.3 Loosening						
Sadr 1977 (10)	1	11	9	14	25.3%	0.14 [0.02 , 0.95]
Brandfoot 2000 (11)	2	38	1	53	19.5%	2.79 [0.26 , 29.66]
Figved 2009 (1)	1	112	0	108	12.6%	2.89 [0.12 , 70.27]
Moerman 2017 (12)	5	110	13	91	42.6%	0.32 [0.12 , 0.86]
Subtotal (95% CI)		**271**		**266**	**100.0%**	**0.52 [0.14 , 1.89]**
Total events:	9		23			
Heterogeneity: Tau² = 0.75; Chi² = 5.41, df = 3 (P = 0.14); I² = 45%						
Test for overall effect: Z = 0.99 (P = 0.32)						
2.38.4 Deep infection						
Harper 1994 (13)	1	71	0	66	5.9%	2.79 [0.12 , 67.35]
Santini 2005 (8)	1	53	0	53	6.0%	3.00 [0.12 , 72.02]
Figved 2009 (1)	3	112	1	108	11.9%	2.89 [0.31 , 27.38]
Parker 2010c (2)	6	200	5	200	43.9%	1.20 [0.37 , 3.87]
Taylor 2012 (4)	2	80	3	80	19.4%	0.67 [0.11 , 3.88]
Moerman 2017 (5)	1	110	0	91	5.9%	2.49 [0.10 , 60.31]
Movrin 2020 (6)	3	79	0	79	6.9%	7.00 [0.37 , 133.33]
Subtotal (95% CI)		**705**		**677**	**100.0%**	**1.56 [0.72 , 3.38]**
Total events:	17		9			
Heterogeneity: Tau² = 0.00; Chi² = 2.79, df = 6 (P = 0.83); I² = 0%						
Test for overall effect: Z = 1.12 (P = 0.26)						
2.38.5 Superficial infection						
Sonne-Holm 1982 (14)	1	55	1	57	3.5%	1.04 [0.07 , 16.16]
Emery 1991 (15)	1	27	0	26	2.7%	2.89 [0.12 , 67.96]
Harper 1994 (13)	2	71	3	66	8.7%	0.62 [0.11 , 3.59]
Figved 2009 (1)	1	112	0	108	2.6%	2.89 [0.12 , 70.27]

Analysis 2.38. (Continued)

Harper 1994 (13)	2	71	3	66	8.7%	0.62 [0.11 , 3.59]
Figved 2009 (1)	1	112	0	108	2.6%	2.89 [0.12 , 70.27]
Parker 2010c (16)	4	200	3	200	12.1%	1.33 [0.30 , 5.88]
Taylor 2012 (4)	2	80	2	80	7.1%	1.00 [0.14 , 6.93]
DeAngelis 2012 (17)	1	66	1	64	3.5%	0.97 [0.06 , 15.17]
Moerman 2017 (5)	6	110	3	91	14.5%	1.65 [0.43 , 6.43]
Parker 2020 (7)	2	200	5	200	10.1%	0.40 [0.08 , 2.04]
Fernandez 2022 (9)	13	610	8	615	35.1%	1.64 [0.68 , 3.92]
Subtotal (95% CI)		**1531**		**1507**	**100.0%**	**1.23 [0.73 , 2.06]**
Total events:	33		26			
Heterogeneity: Tau² = 0.00; Chi² = 3.67, df = 9 (P = 0.93); I² = 0%						
Test for overall effect: Z = 0.77 (P = 0.44)						
2.38.6 Dislocation						
Sadr 1977 (10)	0	11	1	14	3.4%	0.42 [0.02 , 9.34]
Harper 1994 (13)	4	71	1	66	7.0%	3.72 [0.43 , 32.42]
Santini 2005 (8)	1	53	0	53	3.3%	3.00 [0.12 , 72.02]
Figved 2009 (1)	5	112	5	108	22.5%	0.96 [0.29 , 3.24]
Parker 2010c (16)	2	200	1	200	5.8%	2.00 [0.18 , 21.88]
Taylor 2012 (4)	2	80	0	80	3.6%	5.00 [0.24 , 102.53]
Moerman 2017 (5)	3	110	5	91	16.7%	0.50 [0.12 , 2.02]
Movrin 2020 (6)	2	79	1	79	5.8%	2.00 [0.19 , 21.61]
Parker 2020 (7)	1	200	2	200	5.8%	0.50 [0.05 , 5.47]
Fernandez 2022 (9)	6	610	6	615	26.0%	1.01 [0.33 , 3.11]
Subtotal (95% CI)		**1526**		**1506**	**100.0%**	**1.08 [0.61 , 1.91]**
Total events:	26		22			
Heterogeneity: Tau² = 0.00; Chi² = 5.16, df = 9 (P = 0.82); I² = 0%						
Test for overall effect: Z = 0.25 (P = 0.80)						
Test for subgroup differences: Chi² = 25.89, df = 5 (P < 0.0001), I² = 80.7%						

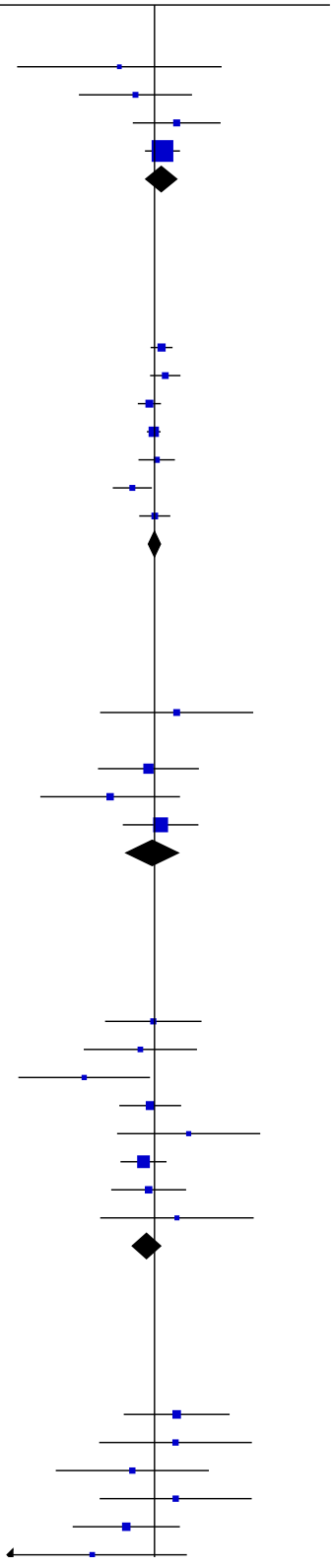


Footnotes

(1) HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 12 months
(2) HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 60 months
(3) HA1: cemented, VerSys stem, unipolar; HA2: uncemented, beaded stem, unipolar; at 12 months
(4) HA1: cemented, Exeter, unipolar; HA2: uncemented, Zweymuller Alloclassic, unipolar; at 24 months
(5) HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 12 months
(6) HA1: cemented, ecofit, bipolar; HA2: uncemented, modular, bipolar; at 24 months
(7) HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 12 months
(8) HA1: cemented, NR, unipolar; HA2: uncemented, NR, unipolar; at 12 months
(9) HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at surgeons preference; at 12 months
(10) HA1: cemented, Thompson, unipolar; HA2: uncemented, Thompson, unipolar; at 17 months
(11) HA1: cemented, Thompson, unipolar; HA2: uncemented, Thompson, unipolar; at 16 months
(12) HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 12 months
(13) HA1: cemented, Thompson, unipolar; HA2: uncemented, Thompson, unipolar; at 2 months
(14) HA1: cemented, Moore, unipolar; HA2: uncemented, Moore, unipolar; at 12 months
(15) HA1: cemented, Thompson, bipolar; HA2: uncemented, Moore, bipolar; at 17/18 months respectively
(16) HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar
(17) HA1: cemented, VerSys stem, unipolar; HA2: uncemented, beaded stem, unipolar; at 12 months

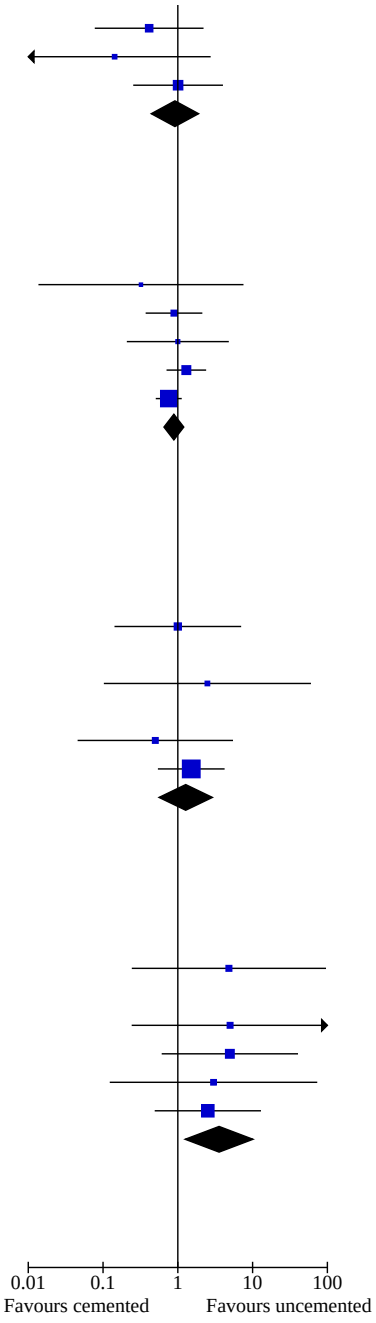
Analysis 2.39. Comparison 2: HA: cemented vs uncemented, Outcome 39: Adverse events unrelated to the implant, fracture, or both

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Random, 95% CI
2.39.1 Acute kidney injury						
Parker 2010c (1)	0	200	1	200	2.3%	0.33 [0.01 , 8.13]
Moerman 2017 (2)	2	110	3	91	7.5%	0.55 [0.09 , 3.23]
Parker 2020 (3)	6	200	3	200	12.4%	2.00 [0.51 , 7.89]
Fernandez 2022 (4)	28	610	22	615	77.9%	1.28 [0.74 , 2.22]
Subtotal (95% CI)		**1120**		**1106**	**100.0%**	**1.23 [0.76 , 2.00]**
Total events:	36		29			
Heterogeneity: Tau² = 0.00; Chi² = 1.94, df = 3 (P = 0.59); I² = 0%						
Test for overall effect: Z = 0.85 (P = 0.39)						
2.39.2 Blood transfusion						
Figved 2009 (5)	47	111	36	106	17.5%	1.25 [0.88 , 1.76]
Parker 2010c (1)	35	200	25	200	11.4%	1.40 [0.87 , 2.25]
DeAngelis 2012 (6)	29	66	33	64	16.5%	0.85 [0.59 , 1.22]
Talsnes 2013 (7)	80	162	87	172	27.2%	0.98 [0.79 , 1.21]
Moerman 2017 (2)	22	110	17	91	8.7%	1.07 [0.61 , 1.89]
Parker 2020 (3)	14	200	28	200	7.7%	0.50 [0.27 , 0.92]
Fernandez 2022 (4)	31	610	31	615	11.1%	1.01 [0.62 , 1.64]
Subtotal (95% CI)		**1459**		**1448**	**100.0%**	**1.00 [0.83 , 1.20]**
Total events:	258		257			
Heterogeneity: Tau² = 0.02; Chi² = 9.32, df = 6 (P = 0.16); I² = 36%						
Test for overall effect: Z = 0.03 (P = 0.98)						
2.39.3 Cerebrovascular accident						
Parker 2010c (1)	2	200	1	200	11.6%	2.00 [0.18 , 21.88]
DeAngelis 2012 (6)	0	66	0	64		Not estimable
Moerman 2017 (2)	3	110	3	91	26.8%	0.83 [0.17 , 4.00]
Parker 2020 (3)	1	200	4	200	14.0%	0.25 [0.03 , 2.22]
Fernandez 2022 (4)	6	610	5	615	47.6%	1.21 [0.37 , 3.94]
Subtotal (95% CI)		**1186**		**1170**	**100.0%**	**0.93 [0.41 , 2.10]**
Total events:	12		13			
Heterogeneity: Tau² = 0.00; Chi² = 2.01, df = 3 (P = 0.57); I² = 0%						
Test for overall effect: Z = 0.18 (P = 0.86)						
2.39.4 Pneumonia/chest infection						
Emery 1991 (8)	3	27	3	26	8.6%	0.96 [0.21 , 4.35]
Figved 2009 (5)	2	112	3	108	6.3%	0.64 [0.11 , 3.77]
Parker 2010c (1)	1	200	9	200	4.6%	0.11 [0.01 , 0.87]
Taylor 2012 (7)	7	80	8	80	21.0%	0.88 [0.33 , 2.30]
DeAngelis 2012 (6)	3	66	1	64	3.9%	2.91 [0.31 , 27.24]
Moerman 2017 (2)	12	110	14	91	37.9%	0.71 [0.35 , 1.46]
Parker 2020 (3)	5	200	6	200	14.3%	0.83 [0.26 , 2.69]
Fernandez 2022 (4)	2	610	1	615	3.4%	2.02 [0.18 , 22.18]
Subtotal (95% CI)		**1405**		**1384**	**100.0%**	**0.78 [0.50 , 1.21]**
Total events:	35		45			
Heterogeneity: Tau² = 0.00; Chi² = 5.73, df = 7 (P = 0.57); I² = 0%						
Test for overall effect: Z = 1.11 (P = 0.27)						
2.39.5 Myocardial infarction						
Santini 2005 (9)	4	53	2	53	19.4%	2.00 [0.38 , 10.46]
Figved 2009 (5)	2	112	1	108	9.3%	1.93 [0.18 , 20.96]
Parker 2010c (1)	1	200	2	200	9.3%	0.50 [0.05 , 5.47]
DeAngelis 2012 (6)	2	66	1	64	9.4%	1.94 [0.18 , 20.87]
Moerman 2017 (2)	2	110	4	91	18.9%	0.41 [0.08 , 2.21]
Parker 2020 (3)	0	200	3	200	6.1%	0.14 [0.01 , 2.75]



Analysis 2.39. (Continued)

Moerman 2017 (2)	2	110	4	91	18.9%	0.41 [0.08 , 2.21]
Parker 2020 (3)	0	200	3	200	6.1%	0.14 [0.01 , 2.75]
Fernandez 2022 (4)	4	610	4	615	27.8%	1.01 [0.25 , 4.01]
Subtotal (95% CI)		**1351**		**1331**	**100.0%**	**0.91 [0.44 , 1.89]**
Total events:	15		17			
Heterogeneity: Tau² = 0.00; Chi² = 4.30, df = 6 (P = 0.64); I² = 0%						
Test for overall effect: Z = 0.24 (P = 0.81)						
2.39.6 Urinary tract infection						
Emery 1991 (8)	0	27	1	26	0.9%	0.32 [0.01 , 7.55]
Santini 2005 (9)	8	53	9	53	12.2%	0.89 [0.37 , 2.13]
Taylor 2012 (7)	3	80	3	80	3.8%	1.00 [0.21 , 4.81]
Moerman 2017 (2)	22	110	14	91	25.0%	1.30 [0.71 , 2.39]
Fernandez 2022 (4)	39	610	52	615	58.1%	0.76 [0.51 , 1.13]
Subtotal (95% CI)		**880**		**865**	**100.0%**	**0.89 [0.65 , 1.20]**
Total events:	72		79			
Heterogeneity: Tau² = 0.00; Chi² = 2.55, df = 4 (P = 0.64); I² = 0%						
Test for overall effect: Z = 0.78 (P = 0.43)						
2.39.7 Venous thromboembolic phenomena (DVT)						
Figved 2009 (5)	0	112	0	108		Not estimable
Parker 2010c (1)	2	200	2	200	17.7%	1.00 [0.14 , 7.03]
DeAngelis 2012 (6)	0	66	0	64		Not estimable
Moerman 2017 (2)	1	110	0	91	6.6%	2.49 [0.10 , 60.31]
Cao 2017 (10)	0	43	0	42		Not estimable
Parker 2020 (3)	1	200	2	200	11.8%	0.50 [0.05 , 5.47]
Fernandez 2022 (4)	9	610	6	615	63.9%	1.51 [0.54 , 4.22]
Subtotal (95% CI)		**1341**		**1320**	**100.0%**	**1.28 [0.56 , 2.90]**
Total events:	13		10			
Heterogeneity: Tau² = 0.00; Chi² = 0.92, df = 3 (P = 0.82); I² = 0%						
Test for overall effect: Z = 0.58 (P = 0.56)						
2.39.8 Venous thromboembolic phenomena (pulmonary embolism)						
Emery 1991 (8)	2	27	0	26	12.2%	4.82 [0.24 , 95.88]
Figved 2009 (5)	0	112	0	108		Not estimable
Parker 2010c (1)	2	200	0	200	11.8%	5.00 [0.24 , 103.49]
Moerman 2017 (2)	6	110	1	91	24.7%	4.96 [0.61 , 40.48]
Parker 2020 (3)	1	200	0	200	10.7%	3.00 [0.12 , 73.20]
Fernandez 2022 (4)	5	610	2	615	40.6%	2.52 [0.49 , 12.94]
Subtotal (95% CI)		**1259**		**1240**	**100.0%**	**3.56 [1.26 , 10.11]**
Total events:	16		3			
Heterogeneity: Tau² = 0.00; Chi² = 0.37, df = 4 (P = 0.98); I² = 0%						
Test for overall effect: Z = 2.39 (P = 0.02)						
Test for subgroup differences: Chi² = 8.69, df = 7 (P = 0.28), I² = 19.4%						



Footnotes

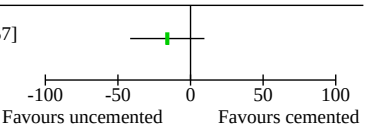
(1) HA1: cemented, Thompson, unipolar; HA2: uncemented, Moore, unipolar; at 60 months
(2) HA1: cemented, Muller, bi/unipolar NR; HA2: uncemented, DB10, bi/unipolar NR; at 12 months
(3) HA1: cemented, Exeter Trauma or CPT, unipolar; HA2: uncemented, Furlong, unipolar; at 12 months
(4) HA1: cemented, stem and head at surgeons preference; HA2: uncemented, stem and head at surgeons preference; at 12 months
(5) HA1: uncemented, modular, bipolar; HA2: uncemented, modular, unipolar; at 12 months
(6) HA1: cemented, VerSys stem, unipolar; HA2: uncemented, beaded stem, unipolar; at 12 months
(7) HA1: cemented, Exeter, unipolar; HA2: uncemented, Zweymuller Alloclassic, unipolar; at 24 months
(8) HA1: cemented, Thompson, bipolar; HA2: uncemented, Moore, bipolar; at 17/18 months respectively
(9) HA1: cemented, NR, unipolar; HA2: uncemented, NR, unipolar; at 12 months
(10) HA1: cemented, stem type and uni/bipolar NR; HA2: uncemented, stem type and uni/bipolar NR; at 6 months

Comparison 3. Mixed HA and THA: cemented vs uncemented

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.1 Functional status (12 months, using HHS, range of scores from 0 to 100; higher scores indicate better function)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.2 HRQoL (12 months, using SF-36, range of scores from 0 to 100; higher scores indicate better quality of life)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.3 Early mortality (≤ 4 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.4 Mortality (12 months)	2	169	Risk Ratio (M-H, Random, 95% CI)	2.02 [0.81, 5.07]
3.5 Late mortality (> 24 months)	1	141	Risk Ratio (M-H, Fixed, 95% CI)	0.88 [0.50, 1.56]
3.6 Pain (12 months, using HHS pain scales; higher values indicate less pain)	1	106	Mean Difference (IV, Fixed, 95% CI)	2.60 [-0.87, 6.07]
3.7 Pain (> 24 months, using HHS pain scales; higher values indicate less pain)	1	86	Mean Difference (IV, Fixed, 95% CI)	3.60 [-0.01, 7.21]
3.8 Unplanned return to theatre (end of follow-up)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.9 Adverse events related to the implant, fracture, or both	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.9.1 Intraoperative periprosthetic fracture	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.9.2 Superficial infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.9.3 Dislocation	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.10 Adverse events unrelated to implant, fracture, or both	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3.10.1 Acute kidney infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3.10.2 Chest infection/pneumonia	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3.10.3 Myocardial infarction	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3.10.4 Urinary tract infection	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected

Analysis 3.1. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 1: Functional status (12 months, using HHS, range of scores from 0 to 100; higher scores indicate better function)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
Moroni 2002 (1)	46	36	15	62	33	13	-16.00 [-41.57 , 9.57]

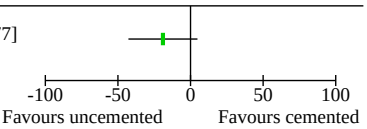


Footnotes

(1) HHS; HA/THA1: cemented, AHS prosthesis, unipolar or THA; HA/THA2: uncemented (HA coated), Furlong, unipolar or THA; at 24 months

Analysis 3.2. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 2: HRQoL (12 months, using SF-36, range of scores from 0 to 100; higher scores indicate better quality of life)

Study or Subgroup	Cemented Mean	SD	Total	Uncemented Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
Moroni 2002 (1)	35	32	15	54	32	13	-19.00 [-42.77 , 4.77]

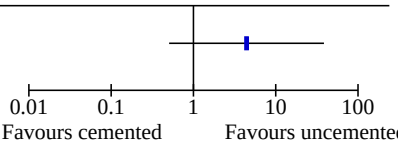


Footnotes

(1) SF-36 (higher scores indicate better QoL). HA/THA1: cemented, AHS prosthesis, unipolar or THA; HA/THA2: uncemented (HA coated), Furlong, unipolar or T

Analysis 3.3. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 3: Early mortality (≤ 4 months)

Study or Subgroup	Cemented Events	Total	Uncemented Events	Total	Risk Ratio M-H, Fixed, 95% CI
Inngul 2015 (1)	4	67	1	74	4.42 [0.51 , 38.55]



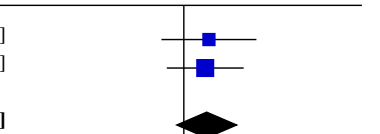
Footnotes

(1) HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: uncemented, hydroxyapatite coa

Analysis 3.4. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 4: Mortality (12 months)

Study or Subgroup	Cemented Events	Total	Uncemented Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Moroni 2002 (1)	5	15	2	13	39.6%	2.17 [0.50 , 9.35]
Inngul 2015 (2)	7	67	4	74	60.4%	1.93 [0.59 , 6.31]
Total (95% CI)		**82**		**87**	**100.0%**	**2.02 [0.81 , 5.07]**
Total events:	12		6			

Heterogeneity: Tau² = 0.00; Chi² = 0.01, df = 1 (P = 0.91); I² = 0%
Test for overall effect: Z = 1.50 (P = 0.13)
Test for subgroup differences: Not applicable



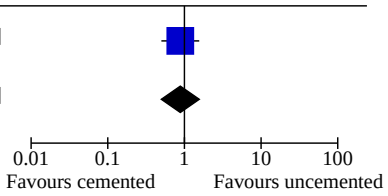
Footnotes

(1) HA/THA1: cemented, AHS prosthesis, unipolar or THA; HA/THA2: uncemented (HA coated), Furlong, unipolar or THA; at 24 months
(2) HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: uncemented, hydroxyapatite coated Bimetric st

Analysis 3.5. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 5: Late mortality (> 24 months)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Inngul 2015 (1)	16	67	20	74	100.0%	0.88 [0.50 , 1.56]
Total (95% CI)		**67**		**74**	**100.0%**	**0.88 [0.50 , 1.56]**
Total events:	16		20			

Heterogeneity: Not applicable
Test for overall effect: Z = 0.43 (P = 0.67)
Test for subgroup differences: Not applicable

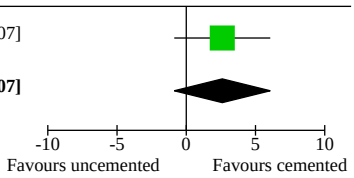


Footnotes
(1) HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: uncemented, hydroxyapatite coated Bimetr

Analysis 3.6. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 6: Pain (12 months, using HHS pain scales; higher values indicate less pain)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Weight	Mean Difference IV, Fixed, 95% CI
Inngul 2015 (1)	39.4	8.8	53	36.8	9.4	53	100.0%	2.60 [-0.87 , 6.07]
Total (95% CI)			**53**			**53**	**100.0%**	**2.60 [-0.87 , 6.07]**

Heterogeneity: Not applicable
Test for overall effect: Z = 1.47 (P = 0.14)
Test for subgroup differences: Not applicable

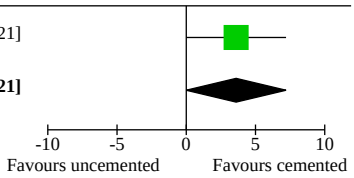


Footnotes
(1) HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: uncemented, hydroxyapatite coated Bimetric stem, unipolar

Analysis 3.7. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 7: Pain (> 24 months, using HHS pain scales; higher values indicate less pain)

Study or Subgroup	Cemented Mean	Cemented SD	Cemented Total	Uncemented Mean	Uncemented SD	Uncemented Total	Weight	Mean Difference IV, Fixed, 95% CI
Inngul 2015 (1)	40.8	6.6	43	37.2	10.1	43	100.0%	3.60 [-0.01 , 7.21]
Total (95% CI)			**43**			**43**	**100.0%**	**3.60 [-0.01 , 7.21]**

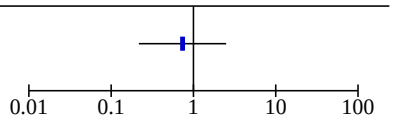
Heterogeneity: Not applicable
Test for overall effect: Z = 1.96 (P = 0.05)
Test for subgroup differences: Not applicable



Footnotes
(1) HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: uncemented, hydroxyapatite coated Bimetric stem, unipolar

Analysis 3.8. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 8: Unplanned return to theatre (end of follow-up)

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Risk Ratio M-H, Fixed, 95% CI
Inngul 2015 (1)	4	67	6	74	0.74 [0.22 , 2.50]

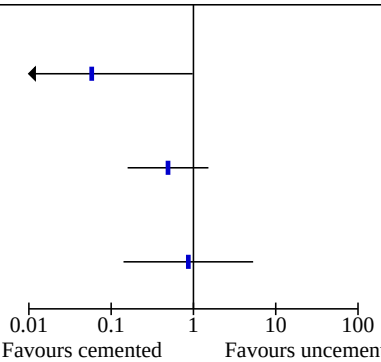


Footnotes

(1) HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: uncemented, hydroxyapatite coa

Analysis 3.9. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 9: Adverse events related to the implant, fracture, or both

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Risk Ratio M-H, Fixed, 95% CI
3.9.1 Intraoperative periprosthetic fracture					
Inngul 2015 (1)	0	67	9	74	0.06 [0.00 , 0.98]
3.9.2 Superficial infection					
Inngul 2015 (1)	4	67	9	74	0.49 [0.16 , 1.52]
3.9.3 Dislocation					
Moroni 2002 (2)	2	15	2	13	0.87 [0.14 , 5.32]

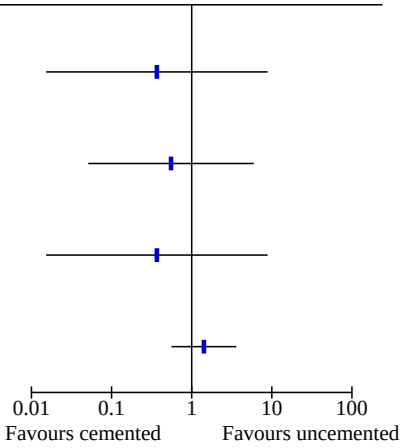


Footnotes

(1) HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: uncemented, hydroxyapatite coa
(2) HA/THA1: cemented, AHS prosthesis, unipolar or THA; HA/THA2: uncemented (HA coated), Furlong, unipolar or THA; at 24 months

Analysis 3.10. Comparison 3: Mixed HA and THA: cemented vs uncemented, Outcome 10: Adverse events unrelated to implant, fracture, or both

Study or Subgroup	Cemented Events	Cemented Total	Uncemented Events	Uncemented Total	Risk Ratio M-H, Random, 95% CI
3.10.1 Acute kidney infection					
Inngul 2015 (1)	0	67	1	74	0.37 [0.02 , 8.87]
3.10.2 Chest infection/pneumonia					
Inngul 2015 (2)	1	67	2	74	0.55 [0.05 , 5.95]
3.10.3 Myocardial infarction					
Inngul 2015 (3)	0	67	1	74	0.37 [0.02 , 8.87]
3.10.4 Urinary tract infection					
Inngul 2015 (3)	9	67	7	74	1.42 [0.56 , 3.60]



Footnotes

(1) Decribed as "acute renal failure"; HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: u
(2) HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: uncemented, hydroxyapatite coate
(3) HA/THA1: cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup; HA/THA2: uncemented, hydroxyapatite coated

Comparison 4. Bipolar HA vs unipolar HA

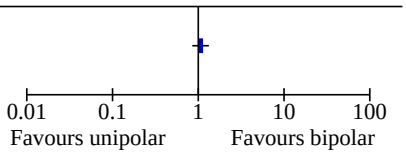
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.1 ADL (12 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4.2 Delirium/confusion	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4.3 Functional status (12 months; using different measurement tools; higher scores indicate better function)	2	299	Std. Mean Difference (IV, Random, 95% CI)	-0.04 [-0.27, 0.19]
4.4 Functional status (12 months. HHS; excellent and good)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4.5 Functional status (> 24 months. HHS; excellent or good)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
4.6 Early HRQoL (≤ 4 months)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4.7 HRQoL (12 months)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4.8 Mobility (Get up and Go Test; in seconds)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4.9 Mobility (6 minute walk test; in metres)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.10 Early mortality (≤ 4 months)	4	573	Risk Ratio (M-H, Random, 95% CI)	0.94 [0.54, 1.64]
4.11 Mortality (12 months)	8	839	Risk Ratio (M-H, Random, 95% CI)	1.17 [0.89, 1.53]
4.11.1 Cemented	7	799	Risk Ratio (M-H, Random, 95% CI)	1.18 [0.90, 1.55]
4.11.2 Uncemented	1	40	Risk Ratio (M-H, Random, 95% CI)	0.33 [0.01, 7.72]
4.12 Late mortality (> 24 months)	2	362	Risk Ratio (M-H, Random, 95% CI)	0.94 [0.72, 1.23]
4.13 Unplanned return to theatre (end of follow-up)	4	532	Risk Ratio (M-H, Random, 95% CI)	1.08 [0.44, 2.64]
4.13.1 Cemented	3	482	Risk Ratio (M-H, Random, 95% CI)	1.71 [0.73, 3.99]
4.13.2 Cemented and uncemented	1	50	Risk Ratio (M-H, Random, 95% CI)	0.29 [0.07, 1.24]
4.14 Pain (categorical data; no pain, or mild pain)	2	300	Risk Ratio (M-H, Random, 95% CI)	1.22 [0.82, 1.82]
4.15 Pain (12 months)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4.16 Length of hospital stay (days)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4.17 Discharge destination: return to preoperative residence	2	381	Risk Ratio (M-H, Random, 95% CI)	0.95 [0.84, 1.08]
4.18 Adverse events related to implant, fracture, or both	10		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
4.18.1 Periprosthetic fracture	1	120	Risk Ratio (M-H, Random, 95% CI)	7.00 [0.37, 132.66]
4.18.2 Superficial infection	1	261	Risk Ratio (M-H, Random, 95% CI)	2.41 [0.48, 12.18]
4.18.3 Deep infection	7	1122	Risk Ratio (M-H, Random, 95% CI)	1.10 [0.44, 2.71]
4.18.4 Dislocation	9	1274	Risk Ratio (M-H, Random, 95% CI)	0.62 [0.28, 1.38]
4.19 Adverse event unrelated to implant, fracture, or both	4		Risk Ratio (M-H, Random, 95% CI)	Subtotals only

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.19.1 Acute kidney injury	1	261	Risk Ratio (M-H, Random, 95% CI)	2.89 [0.12, 70.25]
4.19.2 Blood transfusion	1	115	Risk Ratio (M-H, Random, 95% CI)	0.91 [0.51, 1.62]
4.19.3 Cerebrovascular accident	2	436	Risk Ratio (M-H, Random, 95% CI)	1.57 [0.20, 12.69]
4.19.4 Pneumonia/chest infection	3	556	Risk Ratio (M-H, Random, 95% CI)	0.61 [0.10, 3.86]
4.19.5 Myocardial infarction	3	556	Risk Ratio (M-H, Random, 95% CI)	0.69 [0.11, 4.32]
4.19.6 Urinary tract infection	1	261	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.29, 3.25]
4.19.7 Venous thromboembolic phenomena (DVT)	2	381	Risk Ratio (M-H, Random, 95% CI)	3.84 [0.43, 34.45]
4.19.8 Venous thromboembolic phenomena (pulmonary embolism)	1	120	Risk Ratio (M-H, Random, 95% CI)	3.00 [0.12, 72.20]

Analysis 4.1. Comparison 4: Bipolar HA vs unipolar HA, Outcome 1: ADL (12 months)

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Risk Ratio M-H, Fixed, 95% CI
Hedbeck 2011 (1)	36	46	39	53	1.06 [0.85 , 1.33]

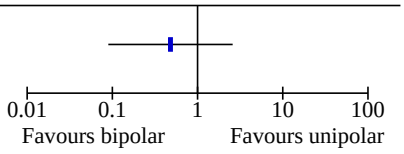


Footnotes

(1) Katz Index A and B; HA1: cemented, UHR Stryker, bipolar; HA2: cemented, Exeter modular, unipolar; at 12 months

Analysis 4.2. Comparison 4: Bipolar HA vs unipolar HA, Outcome 2: Delirium/confusion

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Risk Ratio M-H, Fixed, 95% CI
Stoffel 2013 (1)	2	133	4	128	0.48 [0.09 , 2.58]



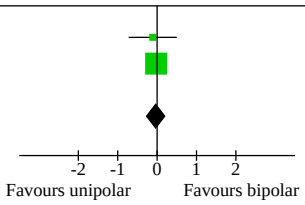
Footnotes

(1) HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 months

Analysis 4.3. Comparison 4: Bipolar HA vs unipolar HA, Outcome 3: Functional status (12 months; using different measurement tools; higher scores indicate better function)

Study or Subgroup	Bipolar Mean	Bipolar SD	Bipolar Total	Unipolar Mean	Unipolar SD	Unipolar Total	Weight	Std. Mean Difference IV, Random, 95% CI
Cornell 1998 (1)	63.2	15	33	64.9	15	15	14.1%	-0.11 [-0.72 , 0.50]
Stoffel 2013 (2)	58.9	14.9	129	59.3	17.4	122	85.9%	-0.02 [-0.27 , 0.22]
Total (95% CI)			**162**			**137**	**100.0%**	**-0.04 [-0.27 , 0.19]**

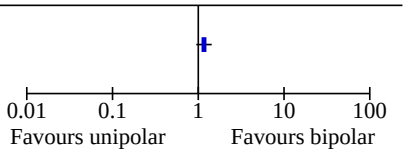
Heterogeneity: Tau² = 0.00; Chi² = 0.07, df = 1 (P = 0.80); I² = 0%
Test for overall effect: Z = 0.32 (P = 0.75)
Test for subgroup differences: Not applicable



Footnotes
(1) "Johansen hip score" (higher score indicate better function); HA1: cemented, modular, bipolar; HA2: cemented, modular, unipolar; at 6 months
(2) HHS (higher scores indicate better function); HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 months

Analysis 4.4. Comparison 4: Bipolar HA vs unipolar HA, Outcome 4: Functional status (12 months. HHS; excellent and good)

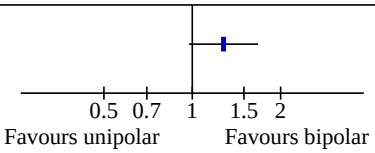
Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Risk Ratio M-H, Fixed, 95% CI
Malhotra 1995 (1)	29	32	28	36	1.17 [0.95 , 1.43]



Footnotes
(1) Reported as Devas and Hinves; HA1: uncemented, Bateman type, bipolar; HA2: uncemented; Austin-Moore; unipolar; at 12 months

Analysis 4.5. Comparison 4: Bipolar HA vs unipolar HA, Outcome 5: Functional status (> 24 months. HHS; excellent or good)

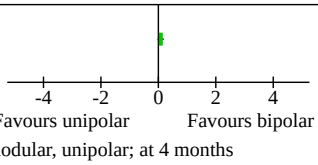
Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Risk Ratio M-H, Fixed, 95% CI
Abdelkhalek 2011 (1)	23	25	18	25	1.28 [0.98 , 1.67]



Footnotes
(1) HHS. HA1: mixed cemented/uncemented, bipolar; mixed cemented/uncemented, unipolar; average follow up 4.4 years

Analysis 4.6. Comparison 4: Bipolar HA vs unipolar HA, Outcome 6: Early HRQoL (≤ 4 months)

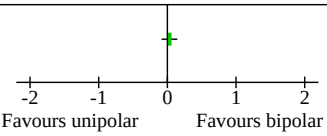
Study or Subgroup	Bipolar Mean	Bipolar SD	Bipolar Total	Unipolar Mean	Unipolar SD	Unipolar Total	Mean Difference IV, Fixed, 95% CI
Hedbeck 2011 (1)	0.62	0.3	56	0.54	0.29	59	0.08 [-0.03 , 0.19]



Footnotes
(1) EQ-5D (higher scores indicate better QoL). HA1: cemented, UHR Stryker, bipolar; HA2: cemented, Exeter modular, unipolar; at 4 months

Analysis 4.7. Comparison 4: Bipolar HA vs unipolar HA, Outcome 7: HRQoL (12 months)

Study or Subgroup	Bipolar Mean	Bipolar SD	Bipolar Total	Unipolar Mean	Unipolar SD	Unipolar Total	Mean Difference IV, Fixed, 95% CI
Hedbeck 2011 (1)	0.63	0.28	46	0.6	0.3	53	0.03 [-0.08 , 0.14]

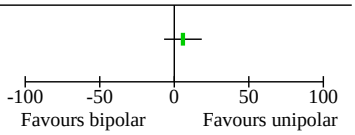


Footnotes

(1) EQ-5D (higher scores indicate better QoL). HA1: cemented, UHR Stryker, bipolar; HA2: cemented, Exeter modular, unipolar; at 12 months

Analysis 4.8. Comparison 4: Bipolar HA vs unipolar HA, Outcome 8: Mobility (Get up and Go Test; in seconds)

Study or Subgroup	Bipolar Mean	Bipolar SD	Bipolar Total	Unipolar Mean	Unipolar SD	Unipolar Total	Mean Difference IV, Fixed, 95% CI
Cornell 1998 (1)	33.1	20	33	27.3	21	15	5.80 [-6.83 , 18.43]

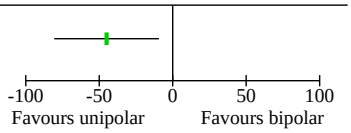


Footnotes

(1) "get up and go test"; HA1: cemented, modular, bipolar; HA2: cemented, modular, unipolar; at 6 months

Analysis 4.9. Comparison 4: Bipolar HA vs unipolar HA, Outcome 9: Mobility (6 minute walk test; in metres)

Study or Subgroup	Bipolar Mean	Bipolar SD	Bipolar Total	Unipolar Mean	Unipolar SD	Unipolar Total	Mean Difference IV, Fixed, 95% CI
Stoffel 2013 (1)	138.2	126.2	94	183.2	121.8	92	-45.00 [-80.64 , -9.36]



Footnotes

(1) Using 6MWT (in metres - further distance = better mobility); HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 m

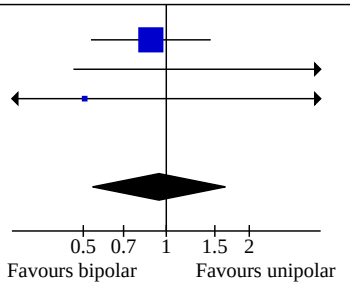
Analysis 4.10. Comparison 4: Bipolar HA vs unipolar HA, Outcome 10: Early mortality (≤ 4 months)

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Weight	Risk Ratio M-H, Random, 95% CI
Calder 1996 (1)	22	118	28	132	88.2%	0.88 [0.53 , 1.45]
Hedbeck 2011 (2)	4	60	1	60	6.4%	4.00 [0.46 , 34.75]
Kanto 2014 (3)	1	87	2	88	5.3%	0.51 [0.05 , 5.48]
Figved 2018 (4)	0	14	0	14		Not estimable
Total (95% CI)		**279**		**294**	**100.0%**	**0.94 [0.54 , 1.64]**
Total events:	27		31			

Heterogeneity: Tau² = 0.03; Chi² = 2.07, df = 2 (P = 0.35); I² = 3%

Test for overall effect: Z = 0.22 (P = 0.83)

Test for subgroup differences: Not applicable



Footnotes

(1) HA1: cemented, Monk, bipolar; HA2: cemented, Thompson; at 4 months

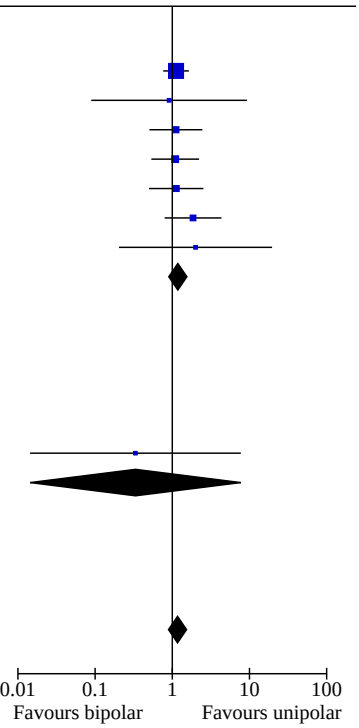
(2) HA1: cemented, UHR Stryker, bipolar; HA2: cemented, Exeter modular, unipolar; at 4 months

(3) HA1: cemented, vario cup, bipolar; HA2: cemented, Lubinus, unipolar; mortality during hospital stay

(4) HA1: cemented, modular, bipolar; HA2: cemented, modular, unipolar; at 3 months

Analysis 4.11. Comparison 4: Bipolar HA vs unipolar HA, Outcome 11: Mortality (12 months)

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Weight	Risk Ratio M-H, Random, 95% CI
4.11.1 Cemented						
Calder 1996 (1)	37	118	37	132	49.5%	1.12 [0.76 , 1.64]
Cornell 1998 (2)	2	33	1	15	1.3%	0.91 [0.09 , 9.27]
Davison 2001 (1)	12	97	10	90	11.6%	1.11 [0.51 , 2.45]
Raia 2003 (3)	12	55	12	60	14.3%	1.09 [0.54 , 2.22]
Jeffcote 2010 (4)	8	24	8	27	11.0%	1.13 [0.50 , 2.53]
Hedbeck 2011 (5)	13	60	7	60	10.1%	1.86 [0.80 , 4.33]
Figved 2018 (6)	2	14	1	14	1.4%	2.00 [0.20 , 19.62]
Subtotal (95% CI)		**401**		**398**	**99.3%**	**1.18 [0.90 , 1.55]**
Total events:	86		76			
Heterogeneity: Tau² = 0.00; Chi² = 1.52, df = 6 (P = 0.96); I² = 0%						
Test for overall effect: Z = 1.20 (P = 0.23)						
4.11.2 Uncemented						
Patel 2008 (7)	0	20	1	20	0.7%	0.33 [0.01 , 7.72]
Subtotal (95% CI)		**20**		**20**	**0.7%**	**0.33 [0.01 , 7.72]**
Total events:	0		1			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.69 (P = 0.49)						
Total (95% CI)		**421**		**418**	**100.0%**	**1.17 [0.89 , 1.53]**
Total events:	86		77			
Heterogeneity: Tau² = 0.00; Chi² = 2.13, df = 7 (P = 0.95); I² = 0%						
Test for overall effect: Z = 1.14 (P = 0.25)						
Test for subgroup differences: Chi² = 0.62, df = 1 (P = 0.43), I² = 0%						



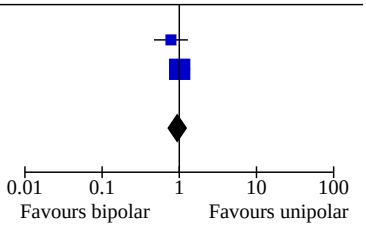
Footnotes

(1) HA1: cemented, Monk, bipolar; HA2: cemented, Thompson; at 12 months
(2) HA1: cemented, modular, bipolar; HA2: cemented, modular, unipolar; 6 months
(3) HA1: cemented, Centrax, bipolar; HA2: cemented, Unitrax; unipolar; at 12 months
(4) HA1: cemented, Centrax, bipolar; HA2: cemented, Unitrax; unipolar; 24 months
(5) HA1: cemented, UHR Stryker, bipolar; HA2: cemented, Exeter modular, unipolar; at 12 months
(6) HA1: cemented, modular, bipolar; HA2: cemented, modular, unipolar; at 12 months
(7) HA1: uncemented; medical internation stem; bipolar; HA2: uncemented; Thompson; unipolar; at 13 months

Analysis 4.12. Comparison 4: Bipolar HA vs unipolar HA, Outcome 12: Late mortality (> 24 months)

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Weight	Risk Ratio M-H, Random, 95% CI
Davison 2001 (1)	21	97	25	90	28.1%	0.78 [0.47 , 1.29]
Kanto 2014 (2)	41	87	41	88	71.9%	1.01 [0.74 , 1.39]
Total (95% CI)		**184**		**178**	**100.0%**	**0.94 [0.72 , 1.23]**
Total events:	62		66			

Heterogeneity: Tau² = 0.00; Chi² = 0.76, df = 1 (P = 0.38); I² = 0%
Test for overall effect: Z = 0.45 (P = 0.65)
Test for subgroup differences: Not applicable



Footnotes
(1) HA1: cemented, Monk, bipolar; HA2: cemented, Thompson; at 36 months
(2) HA1: cemented, vario cup, bipolar; HA2: cemented, Lubinus, unipolar; at 5 years

Analysis 4.13. Comparison 4: Bipolar HA vs unipolar HA, Outcome 13: Unplanned return to theatre (end of follow-up)

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Weight	Risk Ratio M-H, Random, 95% CI
4.13.1 Cemented						
Davison 2001 (1)	5	97	3	90	26.9%	1.55 [0.38 , 6.29]
Hedbeck 2011 (2)	6	60	3	60	28.6%	2.00 [0.52 , 7.63]
Kanto 2014 (3)	3	87	2	88	19.4%	1.52 [0.26 , 8.86]
Subtotal (95% CI)		**244**		**238**	**74.8%**	**1.71 [0.73 , 3.99]**
Total events:	14		8			

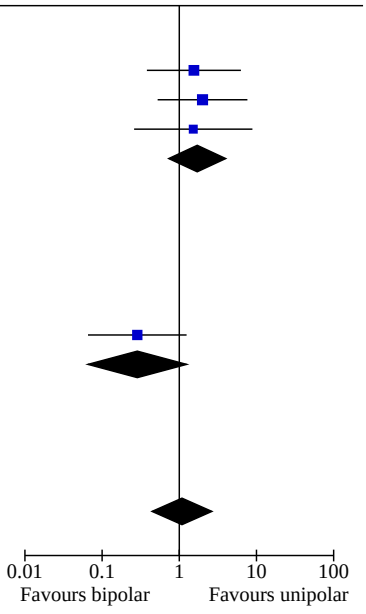
Heterogeneity: Tau² = 0.00; Chi² = 0.09, df = 2 (P = 0.96); I² = 0%
Test for overall effect: Z = 1.23 (P = 0.22)

4.13.2 Cemented and uncemented						
Abdelkhalek 2011 (4)	2	25	7	25	25.2%	0.29 [0.07 , 1.24]
Subtotal (95% CI)		**25**		**25**	**25.2%**	**0.29 [0.07 , 1.24]**
Total events:	2		7			

Heterogeneity: Not applicable
Test for overall effect: Z = 1.67 (P = 0.09)

Total (95% CI)		**269**		**263**	**100.0%**	**1.08 [0.44 , 2.64]**
Total events:	16		15			

Heterogeneity: Tau² = 0.26; Chi² = 4.36, df = 3 (P = 0.23); I² = 31%
Test for overall effect: Z = 0.18 (P = 0.86)
Test for subgroup differences: Chi² = 4.26, df = 1 (P = 0.04), I² = 76.5%

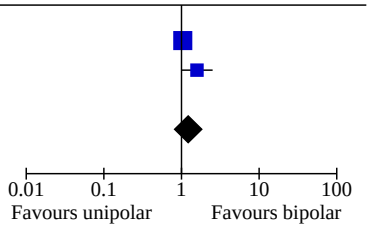


Footnotes
(1) HA1: cemented, Monk, bipolar; HA2: cemented, Thompson; at 36 months
(2) HA1: cemented, UHR Stryker, bipolar; HA2: cemented, Exeter modular, unipolar; at 12 months
(3) HA1: cemented, vario cup, bipolar; HA2: cemented, Lubinus, unipolar; at 5 years
(4) HA1: mixed cemented/uncemented, bipolar; mixed cemented/uncemented, unipolar; 2 years

Analysis 4.14. Comparison 4: Bipolar HA vs unipolar HA, Outcome 14: Pain (categorical data; no pain, or mild pain)

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Weight	Risk Ratio M-H, Random, 95% CI
Calder 1996 (1)	65	118	70	132	61.9%	1.04 [0.83 , 1.31]
Abdelkhalek 2011 (2)	19	25	12	25	38.1%	1.58 [1.00 , 2.52]
Total (95% CI)		**143**		**157**	**100.0%**	**1.22 [0.82 , 1.82]**
Total events:	84		82			

Heterogeneity: Tau² = 0.05; Chi² = 2.56, df = 1 (P = 0.11); I² = 61%
Test for overall effect: Z = 0.97 (P = 0.33)
Test for subgroup differences: Not applicable

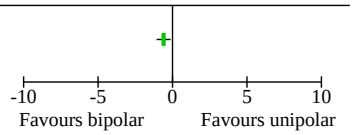


Footnotes

(1) Reported as "No or mild pain"; HA1: cemented, Monk, bipolar; HA2: cemented, Thompson; at 24 months
(2) HA1: mixed cemented/uncemented, bipolar; mixed cemented/uncemented, unipolar; at 48 months

Analysis 4.15. Comparison 4: Bipolar HA vs unipolar HA, Outcome 15: Pain (12 months)

Study or Subgroup	Bipolar Mean	Bipolar SD	Bipolar Total	Unipolar Mean	Unipolar SD	Unipolar Total	Mean Difference IV, Fixed, 95% CI
Stoffel 2013 (1)	1.9	1.6	119	2.5	2	114	-0.60 [-1.07 , -0.13]

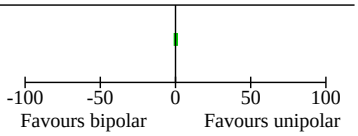


Footnotes

(1) Using Verbal Numerical Rating Score (lower scores indicate less pain); HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipo

Analysis 4.16. Comparison 4: Bipolar HA vs unipolar HA, Outcome 16: Length of hospital stay (days)

Study or Subgroup	Bipolar Mean	Bipolar SD	Bipolar Total	Unipolar Mean	Unipolar SD	Unipolar Total	Mean Difference IV, Fixed, 95% CI
Stoffel 2013 (1)	8	4.8	133	7.8	4.7	128	0.20 [-0.95 , 1.35]



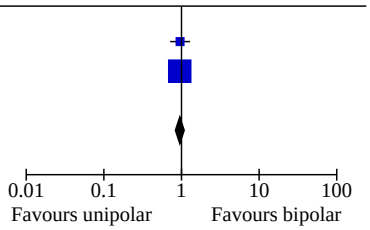
Footnotes

(1) HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar

Analysis 4.17. Comparison 4: Bipolar HA vs unipolar HA, Outcome 17: Discharge destination: return to preoperative residence

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Weight	Risk Ratio M-H, Random, 95% CI
Calder 1996 (1)	48	118	56	132	19.4%	0.96 [0.71 , 1.29]
Kanto 2014 (2)	49	59	63	72	80.6%	0.95 [0.82 , 1.10]
Total (95% CI)		**177**		**204**	**100.0%**	**0.95 [0.84 , 1.08]**
Total events:	97		119			

Heterogeneity: Tau² = 0.00; Chi² = 0.01, df = 1 (P = 0.94); I² = 0%
Test for overall effect: Z = 0.76 (P = 0.45)
Test for subgroup differences: Not applicable

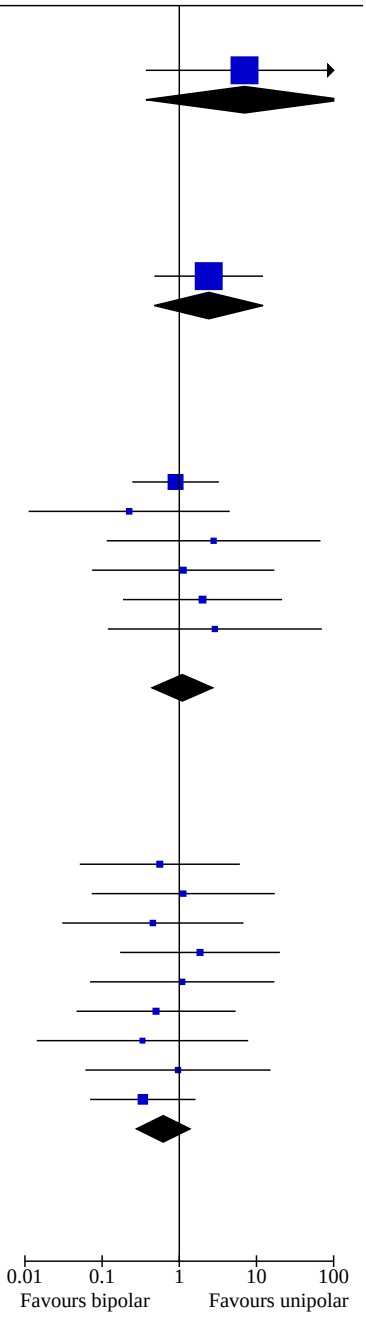


Footnotes

(1) Return to pre-op residence; HA1: cemented, Monk, bipolar; HA2: cemented, Thompson
(2) Returned to home. HA1: cemented, vario cup, bipolar; HA2: cemented, Lubinus, unipolar

Analysis 4.18. Comparison 4: Bipolar HA vs unipolar HA, Outcome 18: Adverse events related to implant, fracture, or both

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Weight	Risk Ratio M-H, Random, 95% CI
4.18.1 Periprosthetic fracture						
Hedbeck 2011 (1)	3	60	0	60	100.0%	7.00 [0.37 , 132.66]
Subtotal (95% CI)		**60**		**60**	**100.0%**	**7.00 [0.37 , 132.66]**
Total events:	3		0			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.30 (P = 0.19)						
4.18.2 Superficial infection						
Stoffel 2013 (2)	5	133	2	128	100.0%	2.41 [0.48 , 12.18]
Subtotal (95% CI)		**133**		**128**	**100.0%**	**2.41 [0.48 , 12.18]**
Total events:	5		2			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.06 (P = 0.29)						
4.18.3 Deep infection						
Calder 1996 (3)	4	118	5	132	49.1%	0.89 [0.25 , 3.25]
Malhotra 1995 (4)	0	32	2	36	9.1%	0.22 [0.01 , 4.50]
Davison 2001 (5)	1	97	0	90	8.1%	2.79 [0.11 , 67.52]
Jeffcote 2010 (6)	1	24	1	27	11.1%	1.13 [0.07 , 17.02]
Hedbeck 2011 (1)	2	60	1	60	14.5%	2.00 [0.19 , 21.47]
Stoffel 2013 (7)	1	133	0	128	8.0%	2.89 [0.12 , 70.25]
Kanto 2014 (8)	0	97	0	88		Not estimable
Subtotal (95% CI)		**561**		**561**	**100.0%**	**1.10 [0.44 , 2.71]**
Total events:	9		9			
Heterogeneity: Tau² = 0.00; Chi² = 2.10, df = 5 (P = 0.83); I² = 0%						
Test for overall effect: Z = 0.20 (P = 0.84)						
4.18.4 Dislocation						
Calder 1996 (3)	1	118	2	132	11.2%	0.56 [0.05 , 6.09]
Malhotra 1995 (9)	1	32	1	36	8.6%	1.13 [0.07 , 17.26]
Cornell 1998 (10)	1	33	1	15	8.7%	0.45 [0.03 , 6.79]
Davison 2001 (5)	2	97	1	90	11.2%	1.86 [0.17 , 20.12]
Raia 2003 (11)	1	55	1	60	8.4%	1.09 [0.07 , 17.02]
Hedbeck 2011 (1)	1	60	2	60	11.3%	0.50 [0.05 , 5.37]
Abdelkhalek 2011 (12)	0	25	1	25	6.4%	0.33 [0.01 , 7.81]
Stoffel 2013 (2)	1	133	1	128	8.4%	0.96 [0.06 , 15.22]
Kanto 2014 (8)	2	87	6	88	25.8%	0.34 [0.07 , 1.62]
Subtotal (95% CI)		**640**		**634**	**100.0%**	**0.62 [0.28 , 1.38]**
Total events:	10		16			
Heterogeneity: Tau² = 0.00; Chi² = 2.07, df = 8 (P = 0.98); I² = 0%						
Test for overall effect: Z = 1.18 (P = 0.24)						
Test for subgroup differences: Chi² = 4.22, df = 3 (P = 0.24), I² = 28.9%						



Footnotes

(1) HA1: cemented, UHR Stryker, bipolar; HA2: cemented, Exeter modular, unipolar; at 12 months
(2) HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 months
(3) HA1: cemented, Monk, bipolar; HA2: cemented, Thompson; at 24 months
(4) HA1: uncemented, Bateman type, bipolar; HA2: uncemented; Austin-Moore; unipolar; at 2 years
(5) HA1: cemented, Monk, bipolar; HA2: cemented, Thompson; at 36 months
(6) HA1: cemented, Centrax, bipolar; HA2: cemented, Unitrax; unipolar; 24 months
(7) HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 months
(8) HA1: cemented, vario cup, bipolar; HA2: cemented, Lubinus, unipolar; at 60 months

Analysis 4.18. (Continued)

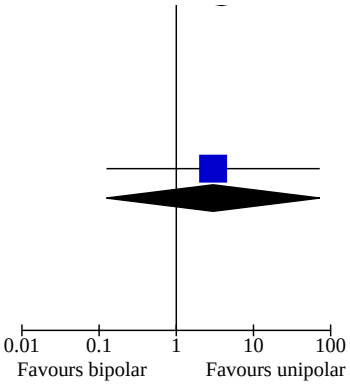
(7) HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 months
(8) HA1: cemented, vario cup, bipolar; HA2: cemented, Lubinus, unipolar; at 60 months
(9) HA1: uncemented, Bateman type, bipolar; HA2: uncemented; Austin-Moore; unipolar; first week after surgery
(10) HA1: cemented, modular, bipolar; HA2: cemented, modular, unipolar; at 6 months
(11) HA1: cemented, Centrax, bipolar; HA2: cemented, Unitrax, unipolar; at 12 months
(12) HA1: mixed cemented/uncemented, bipolar; mixed cemented/uncemented, unipolar; at 48 months

Analysis 4.19. Comparison 4: Bipolar HA vs unipolar HA, Outcome 19: Adverse event unrelated to implant, fracture, or both

Study or Subgroup	Bipolar Events	Bipolar Total	Unipolar Events	Unipolar Total	Weight	Risk Ratio M-H, Random, 95% CI
4.19.1 Acute kidney injury						
Stoffel 2013 (1)	1	133	0	128	100.0%	2.89 [0.12 , 70.25]
Subtotal (95% CI)		**133**		**128**	**100.0%**	**2.89 [0.12 , 70.25]**
Total events:	1		0			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.65 (P = 0.51)						
4.19.2 Blood transfusion						
Raia 2003 (2)	15	55	18	60	100.0%	0.91 [0.51 , 1.62]
Subtotal (95% CI)		**55**		**60**	**100.0%**	**0.91 [0.51 , 1.62]**
Total events:	15		18			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.32 (P = 0.75)						
4.19.3 Cerebrovascular accident						
Stoffel 2013 (1)	1	133	1	128	57.1%	0.96 [0.06 , 15.22]
Kanto 2014 (3)	1	87	0	88	42.9%	3.03 [0.13 , 73.47]
Subtotal (95% CI)		**220**		**216**	**100.0%**	**1.57 [0.20 , 12.69]**
Total events:	2		1			
Heterogeneity: Tau² = 0.00; Chi² = 0.29, df = 1 (P = 0.59); I² = 0%						
Test for overall effect: Z = 0.43 (P = 0.67)						
4.19.4 Pneumonia/chest infection						
Hedbeck 2011 (4)	0	60	2	60	28.5%	0.20 [0.01 , 4.08]
Stoffel 2013 (1)	1	133	3	128	43.1%	0.32 [0.03 , 3.04]
Kanto 2014 (3)	2	87	0	88	28.4%	5.06 [0.25 , 103.83]
Subtotal (95% CI)		**280**		**276**	**100.0%**	**0.61 [0.10 , 3.86]**
Total events:	3		5			
Heterogeneity: Tau² = 0.73; Chi² = 2.74, df = 2 (P = 0.25); I² = 27%						
Test for overall effect: Z = 0.52 (P = 0.60)						
4.19.5 Myocardial infarction						
Hedbeck 2011 (4)	0	60	1	60	33.5%	0.33 [0.01 , 8.02]
Stoffel 2013 (1)	1	133	0	128	33.2%	2.89 [0.12 , 70.25]
Kanto 2014 (3)	0	87	1	88	33.3%	0.34 [0.01 , 8.16]
Subtotal (95% CI)		**280**		**276**	**100.0%**	**0.69 [0.11 , 4.32]**
Total events:	1		2			
Heterogeneity: Tau² = 0.00; Chi² = 1.17, df = 2 (P = 0.56); I² = 0%						
Test for overall effect: Z = 0.40 (P = 0.69)						
4.19.6 Urinary tract infection						
Stoffel 2013 (1)	5	133	5	128	100.0%	0.96 [0.29 , 3.25]
Subtotal (95% CI)		**133**		**128**	**100.0%**	**0.96 [0.29 , 3.25]**
Total events:	5		5			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.06 (P = 0.95)						
4.19.7 Venous thromboembolic phenomena (DVT)						
Hedbeck 2011 (4)	1	60	0	60	47.5%	3.00 [0.12 , 72.20]
Stoffel 2013 (1)	2	133	0	128	52.5%	4.81 [0.23 , 99.30]
Subtotal (95% CI)		**193**		**188**	**100.0%**	**3.84 [0.43 , 34.45]**
Total events:	3		0			
Heterogeneity: Tau² = 0.00; Chi² = 0.04, df = 1 (P = 0.83); I² = 0%						

Analysis 4.19. (Continued)

Total events:	3		0			
Heterogeneity: Tau² = 0.00; Chi² = 0.04, df = 1 (P = 0.83); I² = 0%						
Test for overall effect: Z = 1.20 (P = 0.23)						
4.19.8 Venous thromboembolic phenomena (pulmonary embolism)						
Hedbeck 2011 (4)	1	60	0	60	100.0%	3.00 [0.12 , 72.20]
Subtotal (95% CI)		**60**		**60**	**100.0%**	**3.00 [0.12 , 72.20]**
Total events:	1		0			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.68 (P = 0.50)						
Test for subgroup differences: Chi² = 3.05, df = 7 (P = 0.88), I² = 0%						



Footnotes

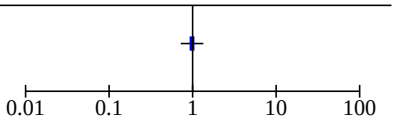
(1) HA1: cemented, Smith & Nephew, bipolar; HA2: cemented, Smith & Nephew, unipolar; at 12 months
(2) HA1: cemented, Centrax, bipolar; HA2: cemented, Unitrax; unipolar; at 12 months
(3) HA1: cemented, vario cup, bipolar; HA2: cemented, Lubinus, unipolar; at 60 months
(4) HA1: cemented, UHR Stryker, bipolar; HA2: cemented, Exeter modular, unipolar; at 12 months

Comparison 5. HA: short stem vs standard stem

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
5.1 Mobility (24 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.2 Mortality (24 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.3 Pain (24 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.4 Adverse events related to implant, fracture, or both	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.4.1 Postoperative periprosthetic fracture	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.4.2 Loosening	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.4.3 Superficial infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
5.4.4 Dislocation	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Analysis 5.1. Comparison 5: HA: short stem vs standard stem, Outcome 1: Mobility (24 months)

Study or Subgroup	Short stem Events	Short stem Total	Standard stem Events	Standard stem Total	Risk Ratio M-H, Fixed, 95% CI
Lim 2020 (1)	27	40	24	35	0.98 [0.72 , 1.34]

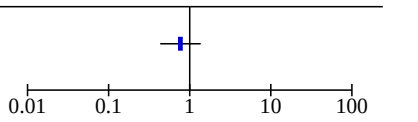


Footnotes

(1) Ambulatory outdoors; HA1: uncemented, short stem, bipolar; HA2: uncemented, standard stem, bipolar; at 2 years

Analysis 5.2. Comparison 5: HA: short stem vs standard stem, Outcome 2: Mortality (24 months)

Study or Subgroup	Short stem Events	Short stem Total	Standard stem Events	Standard stem Total	Risk Ratio M-H, Fixed, 95% CI
Lim 2020 (1)	16	77	20	74	0.77 [0.43 , 1.37]

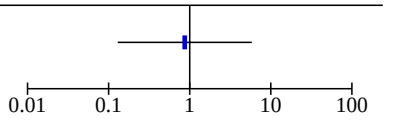


Footnotes

(1) HA1: uncemented, short stem, bipolar; HA2: uncemented, standard stem, bipolar; at 24 months

Analysis 5.3. Comparison 5: HA: short stem vs standard stem, Outcome 3: Pain (24 months)

Study or Subgroup	Short stem Events	Short stem Total	Standard stem Events	Standard stem Total	Risk Ratio M-H, Fixed, 95% CI
Lim 2020 (1)	2	38	2	33	0.87 [0.13 , 5.83]

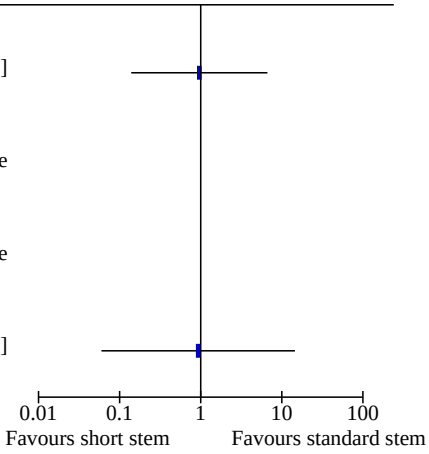


Footnotes

(1) With thigh pain; HA1: uncemented, short stem, bipolar; HA2: uncemented, standard stem, bipolar; at 2 years

Analysis 5.4. Comparison 5: HA: short stem vs standard stem, Outcome 4: Adverse events related to implant, fracture, or both

Study or Subgroup	Short stem Events	Short stem Total	Standard stem Events	Standard stem Total	Risk Ratio M-H, Fixed, 95% CI
5.4.1 Postoperative periprosthetic fracture					
Lim 2020 (1)	2	77	2	74	0.96 [0.14 , 6.65]
5.4.2 Loosening					
Lim 2020	0	40	0	35	Not estimable
5.4.3 Superficial infection					
Lim 2020	0	40	0	35	Not estimable
5.4.4 Dislocation					
Lim 2020	1	58	1	54	0.93 [0.06 , 14.52]



Footnotes

(1) HA1: uncemented, short stem, bipolar; HA2: uncemented, standard stem, bipolar; at 2 years

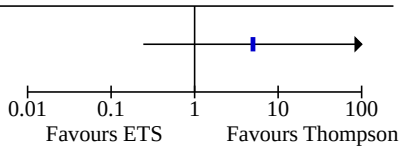
Comparison 6. HA: ETS vs Thompson

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6.1 Delirium	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.2 Early HRQoL (≤ 4 months)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
6.3 Early mobility (freely mobile without aids, or able to walk outdoors with one aid)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.4 Early mortality (≤ 4 months)	2	1164	Risk Ratio (M-H, Random, 95% CI)	1.20 [0.76, 1.88]
6.5 Mortality (12 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.6 Unplanned return to theatre (end of follow-up)	2	1164	Risk Ratio (M-H, Random, 95% CI)	0.46 [0.05, 3.89]
6.7 Adverse events related to implant, fracture, or both	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.7.1 Intraoperative periprosthetic fracture	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.7.2 Deep infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.7.3 Superficial infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.7.4 Dislocation	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6.8 Adverse events unrelated to implant, fracture, or both	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.8.1 Acute kidney injury	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.8.2 Blood transfusion	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.8.3 Cerebrovascular accident	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.8.4 Chest infection/pneumonia	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.8.5 Myocardial infarction	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.8.6 Venous thromboembolic phenomena (DVT)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
6.8.7 Venous thromboembolic phenomena (pulmonary embolism)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Analysis 6.1. Comparison 6: HA: ETS vs Thompson, Outcome 1: Delirium

Study or Subgroup	ETS Events	ETS Total	Thompson Events	Thompson Total	Risk Ratio M-H, Fixed, 95% CI
Parker 2012 (1)	2	100	0	100	5.00 [0.24 , 102.85]

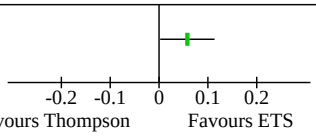


Footnotes

(1) HA1: uncemented, Exeter, unipolar; HA2: cemented, Thompson, unipolar; at 12 months

Analysis 6.2. Comparison 6: HA: ETS vs Thompson, Outcome 2: Early HRQoL (≤ 4 months)

Study or Subgroup	ETS Mean	ETS SD	ETS Total	Thompson Mean	Thompson SD	Thompson Total	Mean Difference IV, Fixed, 95% CI
Sims 2018 (1)	0.379	0.358	315	0.321	0.348	303	0.06 [0.00 , 0.11]

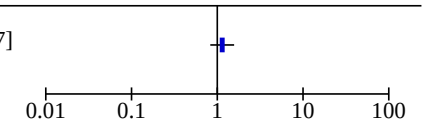


Footnotes

(1) EQ-5D (higher scores indicate better QoL); HA1: uncemented, Exeter, unipolar; HA2: cemented, Thompson, unipolar; at 4 months

Analysis 6.3. Comparison 6: HA: ETS vs Thompson, Outcome 3: Early mobility (freely mobile without aids, or able to walk outdoors with one aid)

Study or Subgroup	ETS Events	ETS Total	Thompson Events	Thompson Total	Risk Ratio M-H, Fixed, 95% CI
Sims 2018 (1)	63	252	53	242	1.14 [0.83 , 1.57]



Footnotes

(1) HA1: uncemented, Exeter, unipolar; HA2: cemented, Thompson, unipolar; at 4 months

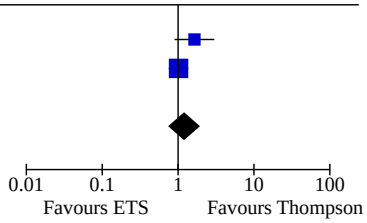
Analysis 6.4. Comparison 6: HA: ETS vs Thompson, Outcome 4: Early mortality (≤ 4 months)

Study or Subgroup	ETS Events	ETS Total	Thompson Events	Thompson Total	Weight	Risk Ratio M-H, Random, 95% CI
Parker 2012 (1)	23	100	14	100	34.6%	1.64 [0.90 , 3.00]
Sims 2018 (2)	74	482	73	482	65.4%	1.01 [0.75 , 1.37]
Total (95% CI)		**582**		**582**	**100.0%**	**1.20 [0.76 , 1.88]**
Total events:	97		87			

Heterogeneity: Tau² = 0.06; Chi² = 1.98, df = 1 (P = 0.16); I² = 49%

Test for overall effect: Z = 0.79 (P = 0.43)

Test for subgroup differences: Not applicable



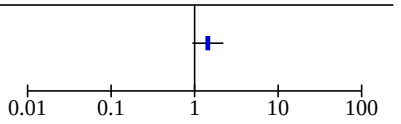
Footnotes

(1) HA1: uncemented, Exeter, unipolar; HA2: cemented, Thompson, unipolar; at 120 days

(2) HA1: uncemented, Exeter, unipolar; HA2: cemented, Thompson, unipolar; at 4 months

Analysis 6.5. Comparison 6: HA: ETS vs Thompson, Outcome 5: Mortality (12 months)

Study or Subgroup	ETS Events	ETS Total	Thompson Events	Thompson Total	Risk Ratio M-H, Fixed, 95% CI
Parker 2012 (1)	36	100	25	100	1.44 [0.94 , 2.21]



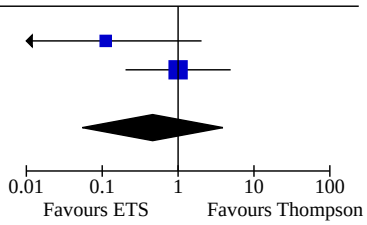
Footnotes

(1) HA1: uncemented, Exeter, unipolar; HA2: cemented, Thompson, unipolar; at 12 months

Analysis 6.6. Comparison 6: HA: ETS vs Thompson, Outcome 6: Unplanned return to theatre (end of follow-up)

Study or Subgroup	ETS Events	ETS Total	Thompson Events	Thompson Total	Weight	Risk Ratio M-H, Random, 95% CI
Parker 2012 (1)	0	100	4	100	35.2%	0.11 [0.01 , 2.04]
Sims 2018 (2)	3	482	3	482	64.8%	1.00 [0.20 , 4.93]
Total (95% CI)		**582**		**582**	**100.0%**	**0.46 [0.05 , 3.89]**
Total events:	3		7			

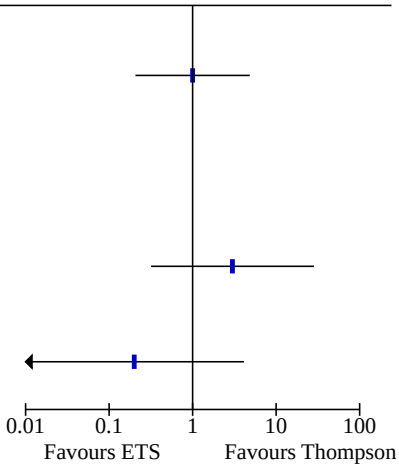
Heterogeneity: Tau² = 1.16; Chi² = 1.81, df = 1 (P = 0.18); I² = 45%
Test for overall effect: Z = 0.71 (P = 0.48)
Test for subgroup differences: Not applicable



Footnotes
(1) HA1: uncemented, Exeter, unipolar; HA2: cemented, Thompson, unipolar; at 12 months
(2) HA1: uncemented, Exeter, unipolar; HA2: cemented, Thompson, unipolar; at 4 months

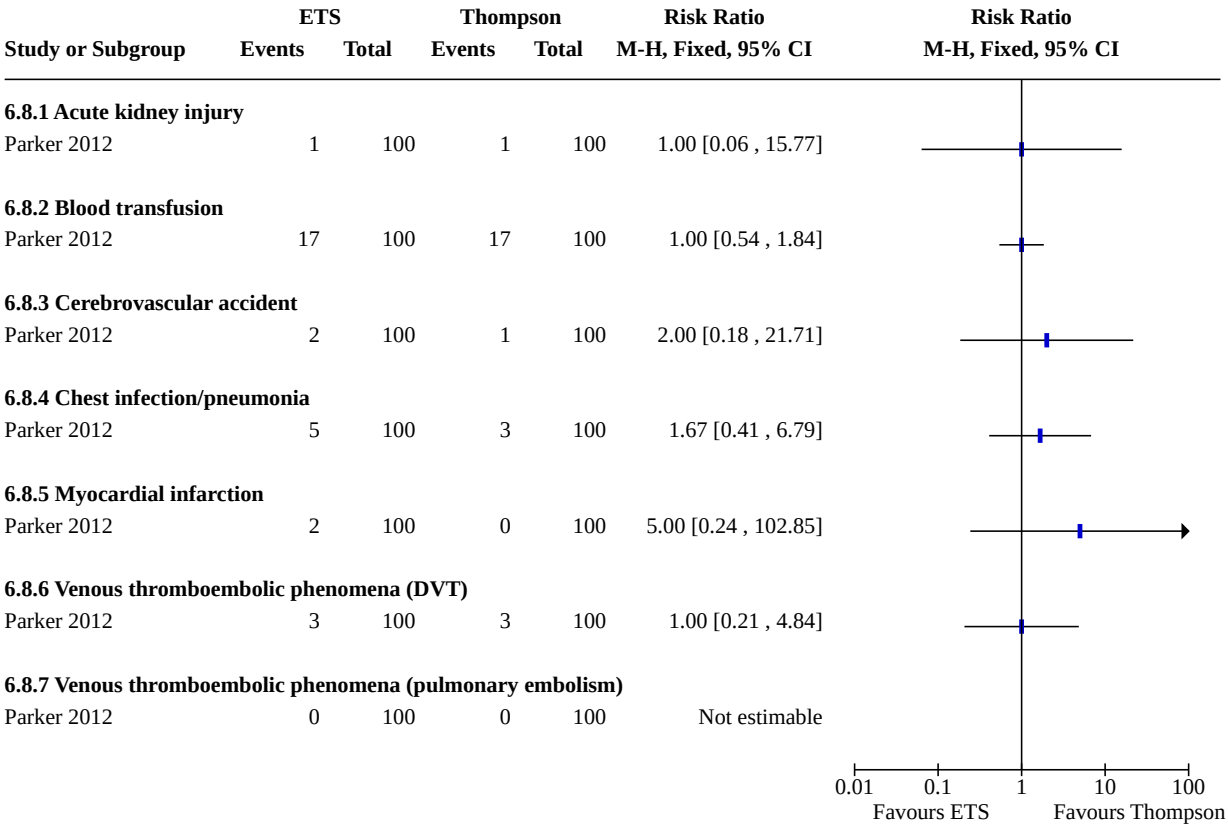
Analysis 6.7. Comparison 6: HA: ETS vs Thompson, Outcome 7: Adverse events related to implant, fracture, or both

Study or Subgroup	ETS Events	ETS Total	Thompson Events	Thompson Total	Risk Ratio M-H, Fixed, 95% CI
6.7.1 Intraoperative periprosthetic fracture					
Parker 2012 (1)	3	100	3	100	1.00 [0.21 , 4.84]
6.7.2 Deep infection					
Parker 2012	0	100	0	100	Not estimable
6.7.3 Superficial infection					
Parker 2012	3	100	1	100	3.00 [0.32 , 28.35]
6.7.4 Dislocation					
Parker 2012	0	100	2	100	0.20 [0.01 , 4.11]



Footnotes
(1) Operative fracture femur; HA1: uncemented, Exeter, unipolar; HA2: cemented, Thompson, unipolar; at 12 months

Analysis 6.8. Comparison 6: HA: ETS vs Thompson, Outcome 8: Adverse events unrelated to implant, fracture, or both

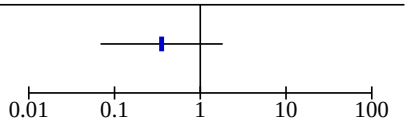


Comparison 7. HA: Furlong vs Moore

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
7.1 Early mortality (≤ 4 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7.2 Mortality (12 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7.3 Unplanned return to theatre (at end of follow-up)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7.4 Pain at rest	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7.5 Adverse events related to the implant, fracture, or both	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7.5.1 Periprosthetic fracture	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7.5.2 Superficial infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
7.5.3 Dislocation	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Analysis 7.1. Comparison 7: HA: Furlong vs Moore, Outcome 1: Early mortality (≤ 4 months)

Study or Subgroup	Furlong Events	Furlong Total	Moore Events	Moore Total	Risk Ratio M-H, Fixed, 95% CI
Livesley 1993 (1)	2	48	4	34	0.35 [0.07 , 1.82]

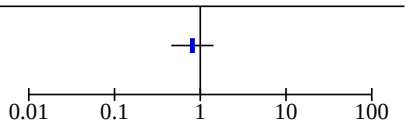


Footnotes

(1) HA1: uncemented, HAC Furlong, bipolar; HA2: uncemented, Moore, bipolar; 30 days

Analysis 7.2. Comparison 7: HA: Furlong vs Moore, Outcome 2: Mortality (12 months)

Study or Subgroup	Furlong Events	Furlong Total	Moore Events	Moore Total	Risk Ratio M-H, Fixed, 95% CI
Livesley 1993 (1)	16	48	14	34	0.81 [0.46 , 1.43]

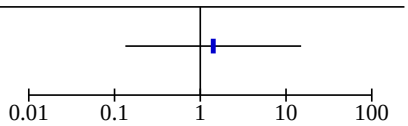


Footnotes

(1) HA1: uncemented, HAC Furlong, bipolar; HA2: uncemented, Moore, bipolar; at 12 months

Analysis 7.3. Comparison 7: HA: Furlong vs Moore, Outcome 3: Unplanned return to theatre (at end of follow-up)

Study or Subgroup	Furlong Events	Furlong Total	Moore Events	Moore Total	Risk Ratio M-H, Fixed, 95% CI
Livesley 1993 (1)	2	48	1	34	1.42 [0.13 , 15.00]

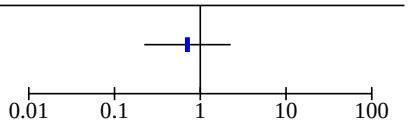


Footnotes

(1) HA1: uncemented, HAC Furlong, bipolar; HA2: uncemented, Moore, bipolar; at 12 months

Analysis 7.4. Comparison 7: HA: Furlong vs Moore, Outcome 4: Pain at rest

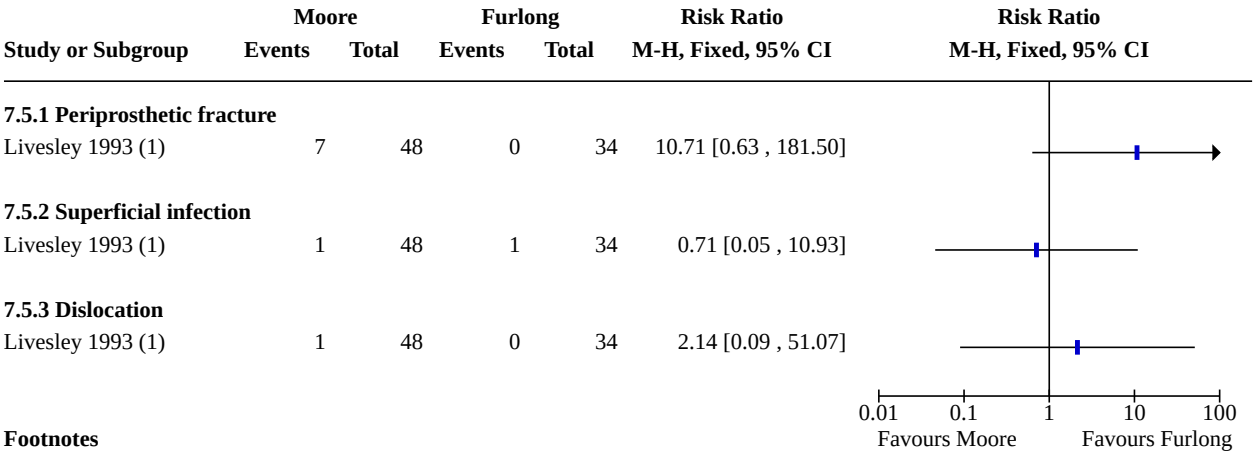
Study or Subgroup	Furlong Events	Furlong Total	Moore Events	Moore Total	Risk Ratio M-H, Fixed, 95% CI
Livesley 1993 (1)	5	48	5	34	0.71 [0.22 , 2.26]



Footnotes

(1) Using five-point scoring system (higher scores indicate less pain). HA1: uncemented, HAC Furlong, bipolar; HA2: uncemented, Moor

Analysis 7.5. Comparison 7: HA: Furlong vs Moore, Outcome 5: Adverse events related to the implant, fracture, or both



Footnotes

(1) HA1: uncemented, HAC Furlong, bipolar; HA2: uncemented, Moore, bipolar; at 12 months

Comparison 8. THA vs HA

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8.1 Early ADL (≤ 4 months, using categorical data)	2	225	Risk Ratio (M-H, Random, 95% CI)	1.03 [0.91, 1.18]
8.2 Early ADL (≤ 4 months; using social mobility scale (lower scores indicate better mobility)	1	83	Mean Difference (IV, Fixed, 95% CI)	-0.10 [-0.46, 0.26]
8.3 ADL (12 months, using categorical data)	2	217	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.86, 1.07]
8.4 ADL (12 months; using different measurement tools; lower scores indicate more independence))	2		Std. Mean Difference (IV, Random, 95% CI)	Totals not selected
8.5 Late ADL (> 24 months; using Barthel Index, range of scores from 0 to 100; higher scores indicate more independence)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
8.6 Delirium	2	357	Risk Ratio (M-H, Random, 95% CI)	1.41 [0.60, 3.33]
8.7 Early functional status (≤ 4 months)	3	395	Std. Mean Difference (IV, Random, 95% CI)	0.27 [0.07, 0.47]
8.8 Functional status (12 months)	8	1273	Std. Mean Difference (IV, Random, 95% CI)	0.29 [0.14, 0.44]
8.9 Functional status (HHS; excellent or good)	2	140	Risk Ratio (M-H, Random, 95% CI)	1.07 [0.98, 1.17]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8.10 Late functional status (> 24 months; using OHS and HHS; higher scores indicate better function)	4	224	Std. Mean Difference (IV, Random, 95% CI)	0.65 [0.23, 1.08]
8.11 Early HRQoL (≤ 4 months)	2	279	Mean Difference (IV, Random, 95% CI)	0.03 [-0.06, 0.12]
8.12 HRQoL (12 months)	4	1158	Std. Mean Difference (IV, Random, 95% CI)	0.19 [0.07, 0.31]
8.13 HRQoL (> 24 months. Using SF-36; higher scores indicate better quality of life)	1	34	Mean Difference (IV, Fixed, 95% CI)	5.90 [-1.99, 13.79]
8.14 Early mobility (≤ 4 months; lower scores indicate better mobility	1	83	Mean Difference (IV, Fixed, 95% CI)	-0.40 [-0.96, 0.16]
8.15 Mobility (12 months, using TUG; lower values indicate better mobility)	2	575	Mean Difference (IV, Random, 95% CI)	-2.74 [-6.82, 1.35]
8.16 Mobility (12 months, using 9-point mobility scale; lower scores indicate better mobility)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
8.17 Mobility (12 months; able to ambulate independently)	2	175	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.71, 1.31]
8.17.1 Modern design	1	40	Risk Ratio (M-H, Random, 95% CI)	0.78 [0.53, 1.17]
8.17.2 First generation uncemented stem	1	135	Risk Ratio (M-H, Random, 95% CI)	1.09 [0.87, 1.36]
8.18 Late mobility (> 24 months; able to ambulate independently)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
8.19 Early mortality (≤ 4 months)	6	725	Risk Ratio (M-H, Random, 95% CI)	0.77 [0.42, 1.42]
8.19.1 Modern design	4	465	Risk Ratio (M-H, Random, 95% CI)	0.88 [0.32, 2.41]
8.19.2 First generation uncemented stem design	1	180	Risk Ratio (M-H, Random, 95% CI)	0.66 [0.30, 1.44]
8.19.3 Age of design is unknown	1	80	Risk Ratio (M-H, Random, 95% CI)	3.00 [0.13, 71.51]
8.20 Mortality (12 months)	11	2667	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.83, 1.22]
8.20.1 Modern design	10	2487	Risk Ratio (M-H, Random, 95% CI)	1.03 [0.82, 1.28]

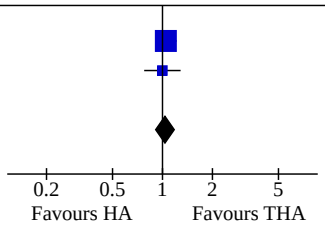
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8.20.2 First generation uncemented stem design	1	180	Risk Ratio (M-H, Random, 95% CI)	0.86 [0.52, 1.42]
8.21 Late mortality (> 24 months)	8	931	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.81, 1.23]
8.21.1 Modern design	7	751	Risk Ratio (M-H, Random, 95% CI)	0.97 [0.72, 1.32]
8.21.2 First generation uncemented stem design	1	180	Risk Ratio (M-H, Random, 95% CI)	0.97 [0.86, 1.10]
8.22 Unplanned return to theatre (end of follow-up)	10	2594	Risk Ratio (M-H, Random, 95% CI)	0.63 [0.37, 1.07]
8.22.1 Modern design	9	2414	Risk Ratio (M-H, Random, 95% CI)	0.86 [0.59, 1.25]
8.22.2 First generation uncemented stem design	1	180	Risk Ratio (M-H, Random, 95% CI)	0.28 [0.12, 0.66]
8.23 Length of hospital stay (days)	3	306	Mean Difference (IV, Random, 95% CI)	0.80 [-1.12, 2.73]
8.24 Pain (12 months: data not combined; lower scores indicate less pain)	9	1435	Std. Mean Difference (IV, Random, 95% CI)	-0.13 [-0.38, 0.12]
8.25 Late pain (> 24 months)	2		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
8.26 Pain (> 24 months: categorical data: no pain)	1	135	Risk Ratio (M-H, Fixed, 95% CI)	1.47 [1.07, 2.00]
8.27 Early pain (≤ 4 months: higher scores indicate less pain)	5	572	Std. Mean Difference (IV, Random, 95% CI)	0.10 [-0.10, 0.30]
8.28 Discharge destination (own home)	2	1612	Risk Ratio (M-H, Random, 95% CI)	0.97 [0.87, 1.08]
8.29 Discharge destination (geriatric ward)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
8.30 Adverse events related to implant, fracture, or both	14		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
8.30.1 Postoperative perioprosthetic fracture	3	1557	Risk Ratio (M-H, Random, 95% CI)	1.08 [0.70, 1.66]
8.30.2 Prosthetic loosening	4	1889	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.17, 2.41]
8.30.3 Deep infection	8	2343	Risk Ratio (M-H, Random, 95% CI)	0.87 [0.50, 1.54]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8.30.4 Superficial infection	10	2495	Risk Ratio (M-H, Random, 95% CI)	1.25 [0.67, 2.30]
8.30.5 Dislocation	12	2719	Risk Ratio (M-H, Random, 95% CI)	1.96 [1.17, 3.27]
8.31 Adverse events unrelated to implant, fracture, or both	8		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
8.31.1 Acute kidney injury	2	1561	Risk Ratio (M-H, Random, 95% CI)	1.09 [0.62, 1.92]
8.31.2 Blood transfusion	2	285	Risk Ratio (M-H, Random, 95% CI)	2.14 [1.27, 3.61]
8.31.3 Cerebrovascular accident	4	657	Risk Ratio (M-H, Random, 95% CI)	1.63 [0.63, 4.21]
8.31.4 Pneumonia/chest infection (reported at > 4 months)	5	613	Risk Ratio (M-H, Random, 95% CI)	0.87 [0.38, 2.00]
8.31.5 Myocardial infarction	4	460	Risk Ratio (M-H, Random, 95% CI)	1.48 [0.48, 4.58]
8.31.6 Urinary tract infection	1	40	Risk Ratio (M-H, Random, 95% CI)	0.19 [0.01, 3.46]
8.31.7 Venous thromboembolic phenomena (DVT)	4	486	Risk Ratio (M-H, Random, 95% CI)	4.25 [0.86, 21.06]
8.31.8 Venous thromboembolic phenomena (pulmonary embolism)	5	673	Risk Ratio (M-H, Random, 95% CI)	0.49 [0.14, 1.63]

Analysis 8.1. Comparison 8: THA vs HA, Outcome 1: Early ADL (≤ 4 months, using categorical data)

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
Blomfeldt 2007 (1)	51	58	47	56	74.2%	1.05 [0.90 , 1.22]
Chammout 2019 (2)	39	57	37	54	25.8%	1.00 [0.78 , 1.29]
Total (95% CI)		**115**		**110**	**100.0%**	**1.03 [0.91 , 1.18]**
Total events:	90		84			

Heterogeneity: Tau² = 0.00; Chi² = 0.12, df = 1 (P = 0.73); I² = 0%
Test for overall effect: Z = 0.52 (P = 0.60)
Test for subgroup differences: Not applicable



Footnotes

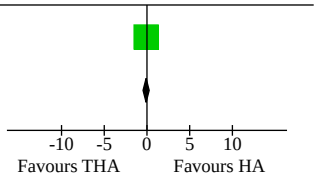
(1) Katz ADL index (A or B); THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28 mm bipolar; at 4 months

(2) Described as "patients who were fully independent"; THA: cemented, CPT stem, 32 mm head, cross linked polyethylene cup; HA: cemented, CPT ste

Analysis 8.2. Comparison 8: THA vs HA, Outcome 2: Early ADL (≤ 4 months; using social mobility scale (lower scores indicate better mobility)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Mean Difference IV, Fixed, 95% CI
Parker 2019 (1)	2.5	0.81	41	2.6	0.85	42	100.0%	-0.10 [-0.46 , 0.26]
Total (95% CI)			**41**			**42**	**100.0%**	**-0.10 [-0.46 , 0.26]**

Heterogeneity: Not applicable
Test for overall effect: Z = 0.55 (P = 0.58)
Test for subgroup differences: Not applicable



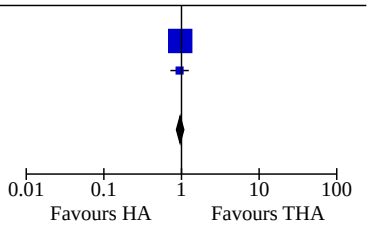
Footnotes

(1) Using social mobility scale (8-point scale; lower scores indicate more independence); THA: cemented, various stems and heads, 32 mm cemented polyethylene cup; H

Analysis 8.3. Comparison 8: THA vs HA, Outcome 3: ADL (12 months, using categorical data)

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
Blomfeldt 2007 (1)	50	56	51	55	84.4%	0.96 [0.86 , 1.08]
Chammout 2019 (2)	36	56	34	50	15.6%	0.95 [0.72 , 1.24]
Total (95% CI)		**112**		**105**	**100.0%**	**0.96 [0.86 , 1.07]**
Total events:	86		85			

Heterogeneity: Tau² = 0.00; Chi² = 0.02, df = 1 (P = 0.88); I² = 0%
Test for overall effect: Z = 0.74 (P = 0.46)
Test for subgroup differences: Not applicable

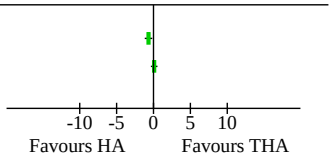


Footnotes

(1) Katz ADL index (A or B); THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28mm bipolar; at 12 months
(2) Patients who were fully independent; THA: cemented, CPT stem, 32 mm head, cross linked polyethylene cup; HA: cemented, CPT stem, unipolar; at

Analysis 8.4. Comparison 8: THA vs HA, Outcome 4: ADL (12 months; using different measurement tools; lower scores indicate more independence))

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Std. Mean Difference IV, Random, 95% CI
Mouzopoulos 2008 (1)	-84.8	14.8	33	-76.8	6.8	30	-0.68 [-1.18 , -0.17]
Parker 2019 (2)	1.9	1.12	39	1.8	1.06	39	0.09 [-0.35 , 0.53]

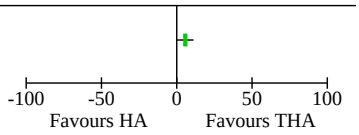


Footnotes

(1) Using BI (higher scores indicate more independence); THA: Plus DePuy; HA: Metete; no details; no details; at 12 months
(2) Social mobility scale (lower scores indicate more independence). HA: cemented, but various stem and heads; THA: cemented; CPS and CPT stems, cemented

Analysis 8.5. Comparison 8: THA vs HA, Outcome 5: Late ADL (> 24 months; using Barthel Index, range of scores from 0 to 100; higher scores indicate more independence)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Mean Difference IV, Fixed, 95% CI
Mouzopoulos 2008 (1)	85.3	11.6	23	79.6	6.3	20	5.70 [0.21 , 11.19]



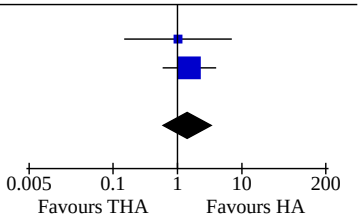
Footnotes

(1) Using BI (higher scores indicate more independence); THA: Plus DePuy; HA: Metete; no details; no details; at 48 months

Analysis 8.6. Comparison 8: THA vs HA, Outcome 6: Delirium

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
Parker 2019 (1)	2	52	2	53	19.8%	1.02 [0.15 , 6.97]
Van den Bekerom 2010 (2)	9	115	7	137	80.2%	1.53 [0.59 , 3.98]
Total (95% CI)		**167**		**190**	**100.0%**	**1.41 [0.60 , 3.33]**
Total events:	11		9			

Heterogeneity: Tau² = 0.00; Chi² = 0.14, df = 1 (P = 0.71); I² = 0%
Test for overall effect: Z = 0.79 (P = 0.43)
Test for subgroup differences: Not applicable



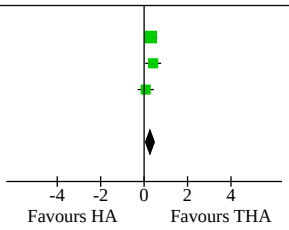
Footnotes

(1) THA: cemented; CPS and CPT stems, cemented 32 mm polyethylene cups; HA: cemented, but various stem and heads
(2) THA: cemented, Weber or Muller stem, 32 mm head, cup not reported; HA: cemented, Weber or Muller stem, bipolar; at 12 months

Analysis 8.7. Comparison 8: THA vs HA, Outcome 7: Early functional status (≤ 4 months)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Std. Mean Difference IV, Random, 95% CI
Keating 2006 (1)	75.9	15	66	71.4	15	102	41.4%	0.30 [-0.01 , 0.61]
Blomfeldt 2007 (2)	82.5	11.5	58	77.5	12.4	58	29.6%	0.42 [0.05 , 0.78]
Chammout 2019 (3)	70	13	57	69	14	54	29.0%	0.07 [-0.30 , 0.45]
Total (95% CI)			**181**			**214**	**100.0%**	**0.27 [0.07 , 0.47]**

Heterogeneity: Tau² = 0.00; Chi² = 1.70, df = 2 (P = 0.43); I² = 0%
Test for overall effect: Z = 2.62 (P = 0.009)
Test for subgroup differences: Not applicable



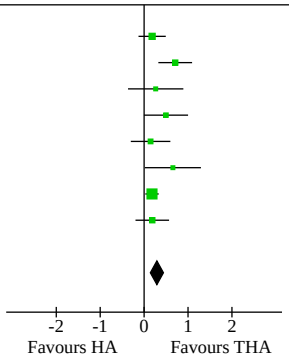
Footnotes

(1) Hip Rating Questionnaire (higher score = better function); THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference,
(2) HHS; THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28 mm bipolar; at 4 months
(3) HHS; THA: cemented, CPT stem, 32 mm head, cross linked polyethylene cup; HA: cemented, CPT stem, unipolar; at 3 months

Analysis 8.8. Comparison 8: THA vs HA, Outcome 8: Functional status (12 months)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Std. Mean Difference IV, Random, 95% CI
Keating 2006 (1)	79.9	17	66	77.1	14	102	16.0%	0.18 [-0.13 , 0.49]
Blomfeldt 2007 (2)	87.2	9.4	56	79.4	12.3	55	11.7%	0.71 [0.32 , 1.09]
Macaulay 2008 (3)	84.2	12	17	80.6	14.3	23	5.0%	0.26 [-0.37 , 0.89]
Mouzopoulos 2008 (4)	81.6	4.9	33	77.81	9.6	30	7.5%	0.50 [-0.00 , 1.00]
Xu 2017 (5)	89.5	4.9	38	88.8	4.5	38	9.0%	0.15 [-0.30 , 0.60]
Sonaje 2017 (6)	88	5.76	20	83.85	6.62	20	4.9%	0.66 [0.02 , 1.29]
HEALTH 2019 (7)	-14.29	15.64	349	-17.22	16.99	320	34.2%	0.18 [0.03 , 0.33]
Chammout 2019 (8)	74	16	56	71	16	50	11.7%	0.19 [-0.20 , 0.57]
Total (95% CI)			**635**			**638**	**100.0%**	**0.29 [0.14 , 0.44]**

Heterogeneity: Tau² = 0.01; Chi² = 9.27, df = 7 (P = 0.23); I² = 25%
Test for overall effect: Z = 3.85 (P = 0.0001)
Test for subgroup differences: Not applicable



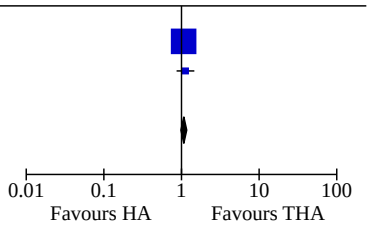
Footnotes

(1) Johansen hip score, function domain (higher score = better function); THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons
(2) HHS; THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28 mm bipolar; at 12 months
(3) HHS; THA: cement, stem, head (≥ 28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 12 months
(4) HHS; THA: Plus DePuy, no details; HA: Metete; no details; at 12 months
(5) HHS; THA: uncemented, no other details provided; HA: uncemented, bipolar; at 12 months
(6) HHS; THA: cemented, other details not reported; HA1: cemented, bipolar; at 24 months
(7) WOMAC (lower scores indicate better function; we inverted the data in meta-analysis); THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem
(8) HHS; THA: cemented, CPT stem, 32 mm head, cross linked polyethylene cup; HA: cemented, CPT stem, unipolar; at 12 months

Analysis 8.9. Comparison 8: THA vs HA, Outcome 9: Functional status (HHS; excellent or good)

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
Ren 2017 (1)	49	50	46	50	89.4%	1.07 [0.97 , 1.17]
Sonaje 2017 (2)	18	20	16	20	10.6%	1.13 [0.86 , 1.46]
Total (95% CI)		**70**		**70**	**100.0%**	**1.07 [0.98 , 1.17]**
Total events:	67		62			

Heterogeneity: Tau² = 0.00; Chi² = 0.19, df = 1 (P = 0.67); I² = 0%
Test for overall effect: Z = 1.57 (P = 0.12)
Test for subgroup differences: Not applicable



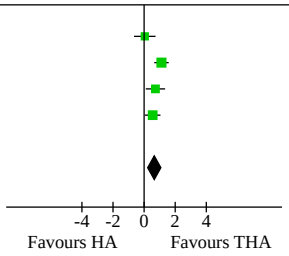
Footnotes

(1) HHS (excellent and good); THA: details not reported; HA: cemented, other details not reported; time point not specified
(2) Modified HHS (scores of 91-100); THA: cemented, other details not reported; HA: cemented, bipolar; at 24 months

Analysis 8.10. Comparison 8: THA vs HA, Outcome 10: Late functional status (> 24 months; using OHS and HHS; higher scores indicate better function)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Std. Mean Difference IV, Random, 95% CI
Baker 2006 (1)	23.1	13.4	21	22.5	13.4	13	20.4%	0.04 [-0.65 , 0.74]
Blomfeldt 2007 (2)	89	8.1	42	75.2	15.4	41	29.1%	1.12 [0.65 , 1.58]
Mouzopoulos 2008 (3)	83.7	4.8	23	79.5	6.5	20	22.8%	0.73 [0.11 , 1.35]
Xu 2017 (4)	87.64	3.99	33	82.81	11.74	31	27.6%	0.55 [0.05 , 1.05]
Total (95% CI)			**119**			**105**	**100.0%**	**0.65 [0.23 , 1.08]**

Heterogeneity: Tau² = 0.10; Chi² = 6.88, df = 3 (P = 0.08); I² = 56%
Test for overall effect: Z = 3.02 (P = 0.003)
Test for subgroup differences: Not applicable



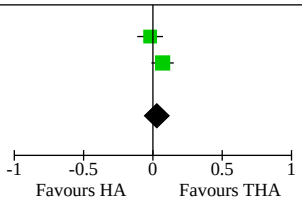
Footnotes

(1) OHS; THA: cemented, CPT stem, 28mm head, polyethylene cemented cup; HA: cemented, CPT stem, unipolar; at 9 years
(2) HHS; THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28 mm bipolar; at 48 months
(3) HHS; THA: Plus DePuy, no details; HA: Metete; no details; at 48 months
(4) HHS; THA: uncemented, no other details provided; HA: uncemented, bipolar; at 60 months

Analysis 8.11. Comparison 8: THA vs HA, Outcome 11: Early HRQoL (≤ 4 months)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Mean Difference IV, Random, 95% CI
Chammout 2019 (1)	0.65	0.26	57	0.67	0.24	54	46.6%	-0.02 [-0.11 , 0.07]
Keating 2006 (2)	0.68	0.24	66	0.61	0.29	102	53.4%	0.07 [-0.01 , 0.15]
Total (95% CI)			**123**			**156**	**100.0%**	**0.03 [-0.06 , 0.12]**

Heterogeneity: Tau² = 0.00; Chi² = 2.05, df = 1 (P = 0.15); I² = 51%
Test for overall effect: Z = 0.63 (P = 0.53)
Test for subgroup differences: Not applicable



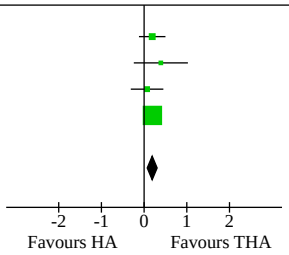
Footnotes

(1) EQ-5D (higher scores indicate better QoL); THA: cemented, CPT stem, 32mm head, cross linked polyethylene cup; HA: cemented, CPT stem, unipolar; at 3 months
(2) EQ-5D (higher scores indicate better QoL); THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference, bipolar; at 4 ı

Analysis 8.12. Comparison 8: THA vs HA, Outcome 12: HRQoL (12 months)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Std. Mean Difference IV, Random, 95% CI
Keating 2006 (1)	0.7	0.29	66	0.64	0.33	102	14.0%	0.19 [-0.12 , 0.50]
Macaulay 2008 (2)	40.2	9.9	17	36.4	9.2	23	3.4%	0.39 [-0.24 , 1.03]
Chammout 2019 (3)	0.68	0.3	56	0.66	0.27	50	9.2%	0.07 [-0.31 , 0.45]
HEALTH 2019 (4)	0.81	0.19	433	0.77	0.22	411	73.4%	0.19 [0.06 , 0.33]
Total (95% CI)			**572**			**586**	**100.0%**	**0.19 [0.07 , 0.31]**

Heterogeneity: Tau² = 0.00; Chi² = 0.78, df = 3 (P = 0.85); I² = 0%
Test for overall effect: Z = 3.20 (P = 0.001)
Test for subgroup differences: Not applicable



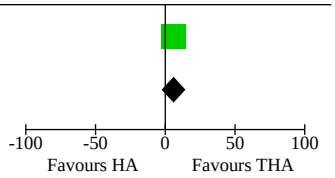
Footnotes

(1) EQ-5D; THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference, bipolar; at 12 months
(2) SF-36 physical component summary score; THA: cement, stem, head (≥ 28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preferenc
(3) EQ-5D; THA: cemented, CPT stem, 32 mm head, cross-linked polyethylene cup; HA: cemented, CPT stem, unipolar; at 12 months using ITT data
(4) EQ-5D; THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 24 months

Analysis 8.13. Comparison 8: THA vs HA, Outcome 13: HRQoL (> 24 months. Using SF-36; higher scores indicate better quality of life)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Mean Difference IV, Fixed, 95% CI
Baker 2006 (1)	37	11.4	21	31.1	11.4	13	100.0%	5.90 [-1.99 , 13.79]
Total (95% CI)			**21**			**13**	**100.0%**	**5.90 [-1.99 , 13.79]**

Heterogeneity: Not applicable
Test for overall effect: Z = 1.47 (P = 0.14)
Test for subgroup differences: Not applicable

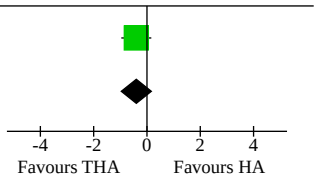


Footnotes
(1) SF-36. THA: cemented, CPT stem, 28mm head, polyethylene cemented cup; HA: cemented, CPT stem, unipolar; at 9 years

Analysis 8.14. Comparison 8: THA vs HA, Outcome 14: Early mobility (≤ 4 months; lower scores indicate better mobility

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Mean Difference IV, Fixed, 95% CI
Parker 2019 (1)	3.4	1.14	41	3.8	1.46	42	100.0%	-0.40 [-0.96 , 0.16]
Total (95% CI)			**41**			**42**	**100.0%**	**-0.40 [-0.96 , 0.16]**

Heterogeneity: Not applicable
Test for overall effect: Z = 1.39 (P = 0.16)
Test for subgroup differences: Not applicable

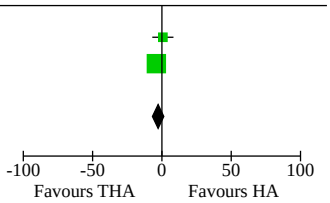


Footnotes
(1) Using 10-point scoring system (lower scores indicate better mobility); THA: cemented, various stems and heads, 32 mm cemented polyethylene cup; HA: cemented, b

Analysis 8.15. Comparison 8: THA vs HA, Outcome 15: Mobility (12 months, using TUG; lower values indicate better mobility)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Mean Difference IV, Random, 95% CI
Macaulay 2008 (1)	17.2	13.5	17	16.5	10.1	23	26.9%	0.70 [-6.93 , 8.33]
HEALTH 2019 (2)	17.2	14.4	279	21.2	32.8	256	73.1%	-4.00 [-8.36 , 0.36]
Total (95% CI)			**296**			**279**	**100.0%**	**-2.74 [-6.82 , 1.35]**

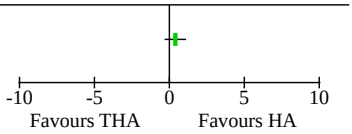
Heterogeneity: Tau² = 0.99; Chi² = 1.10, df = 1 (P = 0.29); I² = 9%
Test for overall effect: Z = 1.31 (P = 0.19)
Test for subgroup differences: Not applicable



Footnotes
(1) TUG; THA: cement, stem, head (≥ 28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 12 months
(2) TUG; THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 24 months

Analysis 8.16. Comparison 8: THA vs HA, Outcome 16: Mobility (12 months, using 9-point mobility scale; lower scores indicate better mobility)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Mean Difference IV, Fixed, 95% CI
Parker 2019 (1)	3	1.68	39	2.6	1.54	39	0.40 [-0.32 , 1.12]

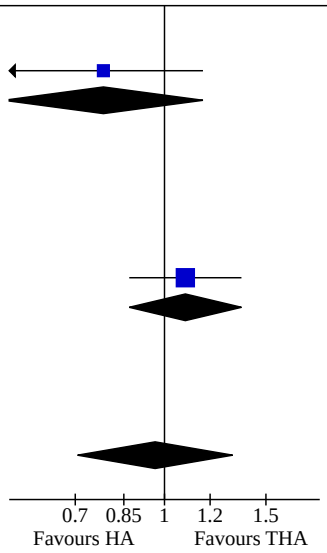


Footnotes

(1) Parker mobility scale (lower scores indicate better mobility). THA: cemented; CPS and CPT stems, cemented 32 mm polyethylene cups; HA: cemented, b

Analysis 8.17. Comparison 8: THA vs HA, Outcome 17: Mobility (12 months; able to ambulate independently)

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
8.17.1 Modern design						
Macaulay 2008 (1)	11	17	19	23	36.9%	0.78 [0.53 , 1.17]
Subtotal (95% CI)		**17**		**23**	**36.9%**	**0.78 [0.53 , 1.17]**
Total events:	11		19			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.20 (P = 0.23)						
8.17.2 First generation uncemented stem						
Ravikumar 2000 (2)	50	69	44	66	63.1%	1.09 [0.87 , 1.36]
Subtotal (95% CI)		**69**		**66**	**63.1%**	**1.09 [0.87 , 1.36]**
Total events:	50		44			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.73 (P = 0.47)						
Total (95% CI)		**86**		**89**	**100.0%**	**0.96 [0.71 , 1.31]**
Total events:	61		63			
Heterogeneity: Tau² = 0.03; Chi² = 1.98, df = 1 (P = 0.16); I² = 49%						
Test for overall effect: Z = 0.24 (P = 0.81)						
Test for subgroup differences: Chi² = 1.98, df = 1 (P = 0.16), I² = 49.4%						



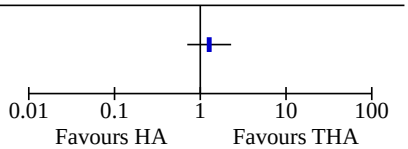
Footnotes

(1) THA: cement, stem, head (≥28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 12 months

(2) THA: cemented, Howse II stem, 32 mm head, semicaptive cup; HA: uncemented, Austin-Moore, unipolar; at 12 months

Analysis 8.18. Comparison 8: THA vs HA, Outcome 18: Late mobility (> 24 months; able to ambulate independently)

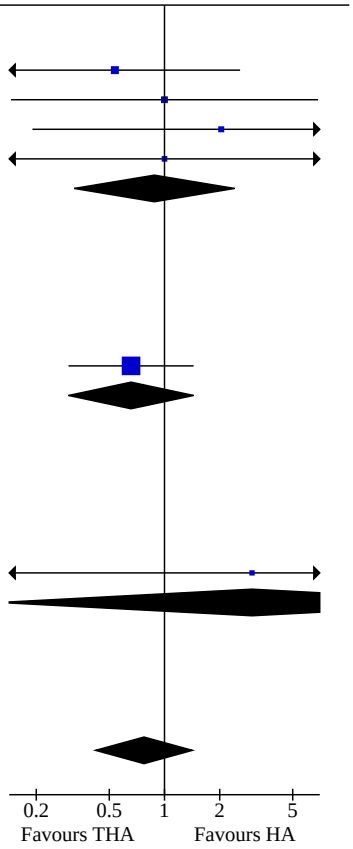
Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Risk Ratio M-H, Fixed, 95% CI
Ravikumar 2000 (1)	13	19	7	13	1.27 [0.71 , 2.29]



Footnotes

(1) THA: cemented, Howse II stem, 32mm head, semicaptive cup; HA: uncemented, Austin-Moore, unipolar; at 13 years

Analysis 8.19. Comparison 8: THA vs HA, Outcome 19: Early mortality (≤ 4 months)



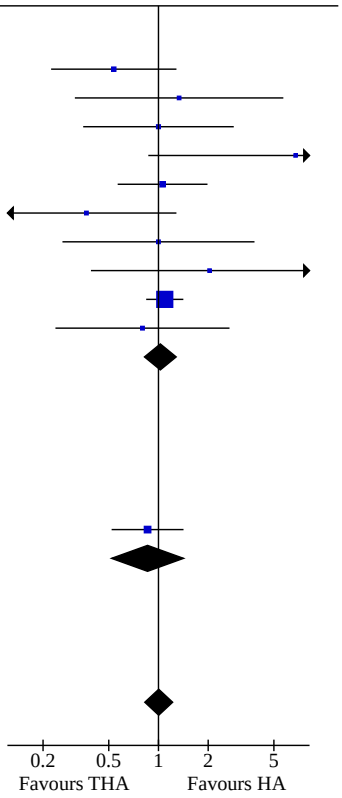
Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
8.19.1 Modern design						
Keating 2006 (1)	2	69	6	111	14.9%	0.54 [0.11 , 2.58]
Blomfeldt 2007 (2)	2	60	2	60	9.9%	1.00 [0.15 , 6.87]
Parker 2019 (3)	2	52	1	53	6.6%	2.04 [0.19 , 21.80]
Iorio 2019 (4)	1	30	1	30	5.0%	1.00 [0.07 , 15.26]
Subtotal (95% CI)		**211**		**254**	**36.4%**	**0.88 [0.32 , 2.41]**
Total events:	7		10			
Heterogeneity: Tau² = 0.00; Chi² = 0.89, df = 3 (P = 0.83); I² = 0%						
Test for overall effect: Z = 0.25 (P = 0.80)						
8.19.2 First generation uncemented stem design						
Ravikumar 2000 (5)	9	89	14	91	59.9%	0.66 [0.30 , 1.44]
Subtotal (95% CI)		**89**		**91**	**59.9%**	**0.66 [0.30 , 1.44]**
Total events:	9		14			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.05 (P = 0.29)						
8.19.3 Age of design is unknown						
Sharma 2016 (6)	1	40	0	40	3.7%	3.00 [0.13 , 71.51]
Subtotal (95% CI)		**40**		**40**	**3.7%**	**3.00 [0.13 , 71.51]**
Total events:	1		0			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.68 (P = 0.50)						
Total (95% CI)		**340**		**385**	**100.0%**	**0.77 [0.42 , 1.42]**
Total events:	17		24			
Heterogeneity: Tau² = 0.00; Chi² = 1.82, df = 5 (P = 0.87); I² = 0%						
Test for overall effect: Z = 0.83 (P = 0.41)						
Test for subgroup differences: Chi² = 0.93, df = 2 (P = 0.63), I² = 0%						

Footnotes

(1) THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference, bipolar; at 4 months
(2) THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28mm bipolar; at 4 months
(3) THA: cemented; CPS and CPT stems, cemented 32mm polyethylene cups; HA: cemented, but various stem and heads; at 4 months
(4) THA: uncemented, Pavistem, DMC; HA: cemented, Exciastem, bipolar; at 1 month
(5) THA: cemented, Howse II stem, 32mm head, semicaptive cup; HA: uncemented, Austin-Moore, unipolar; at 2 months
(6) THA: details not reported; HA1: details not reported; at 1 week

Analysis 8.20. Comparison 8: THA vs HA, Outcome 20: Mortality (12 months)

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
8.20.1 Modern design						
Keating 2006 (1)	6	69	18	111	4.9%	0.54 [0.22 , 1.28]
Blomfeldt 2007 (2)	4	60	3	60	1.8%	1.33 [0.31 , 5.70]
Mouzopoulos 2008 (2)	6	43	6	43	3.4%	1.00 [0.35 , 2.86]
Macaulay 2008 (3)	5	17	1	23	0.9%	6.76 [0.87 , 52.73]
Van den Bekerom 2010 (4)	16	115	18	137	9.6%	1.06 [0.57 , 1.98]
Cadossi 2013 (5)	3	42	8	41	2.4%	0.37 [0.10 , 1.28]
Chammout 2019 (6)	4	60	4	60	2.1%	1.00 [0.26 , 3.81]
Parker 2019 (7)	4	52	2	53	1.4%	2.04 [0.39 , 10.65]
HEALTH 2019 (8)	103	718	95	723	56.0%	1.09 [0.84 , 1.41]
Iorio 2019 (9)	4	30	5	30	2.6%	0.80 [0.24 , 2.69]
Subtotal (95% CI)		**1206**		**1281**	**85.0%**	**1.03 [0.82 , 1.28]**
Total events:	155		160			
Heterogeneity: Tau² = 0.00; Chi² = 9.13, df = 9 (P = 0.43); I² = 1%						
Test for overall effect: Z = 0.23 (P = 0.82)						
8.20.2 First generation uncemented stem design						
Ravikumar 2000 (10)	21	89	25	91	15.0%	0.86 [0.52 , 1.42]
Subtotal (95% CI)		**89**		**91**	**15.0%**	**0.86 [0.52 , 1.42]**
Total events:	21		25			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.59 (P = 0.55)						
Total (95% CI)		**1295**		**1372**	**100.0%**	**1.00 [0.83 , 1.22]**
Total events:	176		185			
Heterogeneity: Tau² = 0.00; Chi² = 9.57, df = 10 (P = 0.48); I² = 0%						
Test for overall effect: Z = 0.04 (P = 0.97)						
Test for subgroup differences: Chi² = 0.41, df = 1 (P = 0.52), I² = 0%						

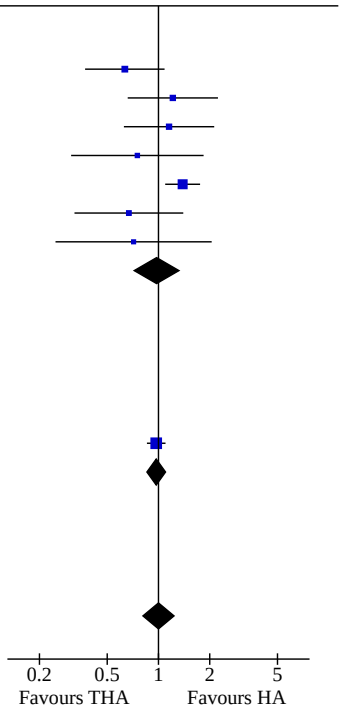


Footnotes

(1) THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference, bipolar; at 24 months
(2) THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28 mm bipolar; at 12 months
(3) THA: cement, stem, head (≥ 28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 6 months
(4) THA: cemented, Weber or Muller stem, 32 mm head, cup not reported; HA: cemented, Weber or Muller stem, bipolar; at 12 months
(5) THA: uncemented, Conus stem, large diameter head, polycarbonate-urethane cup; HA: mixed cemented and uncemented, Centrax stem, bipolar; at 12 mo
(6) THA: cemented, CPT stem, 32mm head, cross linked polyethylene cup; HA: cemented, CPT stem, unipolar; at 24 months
(7) THA: cemented, various stems and heads, 32 mm cemented polyethylene cup; HA: cemented, but various stems and uni/bipolar; at 12 months
(8) THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 24 months
(9) THA: uncemented, Pavi stem, DMC; HA: cemented, Excia stem, bipolar; at 12 months
(10) THA: cemented, Howse II stem, 32mm head, semicaptive cup; HA: uncemented, Austin-Moore, unipolar; at 12 months

Analysis 8.21. Comparison 8: THA vs HA, Outcome 21: Late mortality (> 24 months)

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
8.21.1 Modern design						
Baker 2006 (1)	13	40	21	41	10.7%	0.63 [0.37 , 1.09]
Blomfeldt 2007 (2)	17	60	14	60	8.9%	1.21 [0.66 , 2.24]
Mouzopoulos 2008 (3)	15	43	13	43	8.9%	1.15 [0.63 , 2.13]
Macaulay 2008 (4)	5	17	9	23	4.8%	0.75 [0.31 , 1.84]
Van den Bekerom 2010 (5)	71	115	61	137	24.7%	1.39 [1.10 , 1.76]
Cadossi 2013 (6)	9	47	14	49	6.6%	0.67 [0.32 , 1.40]
Xu 2017 (7)	5	38	7	38	3.6%	0.71 [0.25 , 2.05]
Subtotal (95% CI)		**360**		**391**	**68.2%**	**0.97 [0.72 , 1.32]**
Total events:	135		139			
Heterogeneity: Tau² = 0.07; Chi² = 11.10, df = 6 (P = 0.09); I² = 46%						
Test for overall effect: Z = 0.17 (P = 0.87)						
8.21.2 First generation uncemented stem design						
Ravikumar 2000 (8)	74	89	78	91	31.8%	0.97 [0.86 , 1.10]
Subtotal (95% CI)		**89**		**91**	**31.8%**	**0.97 [0.86 , 1.10]**
Total events:	74		78			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.47 (P = 0.64)						
Total (95% CI)		**449**		**482**	**100.0%**	**1.00 [0.81 , 1.23]**
Total events:	209		217			
Heterogeneity: Tau² = 0.03; Chi² = 12.85, df = 7 (P = 0.08); I² = 46%						
Test for overall effect: Z = 0.00 (P = 1.00)						
Test for subgroup differences: Chi² = 0.00, df = 1 (P = 0.98), I² = 0%						

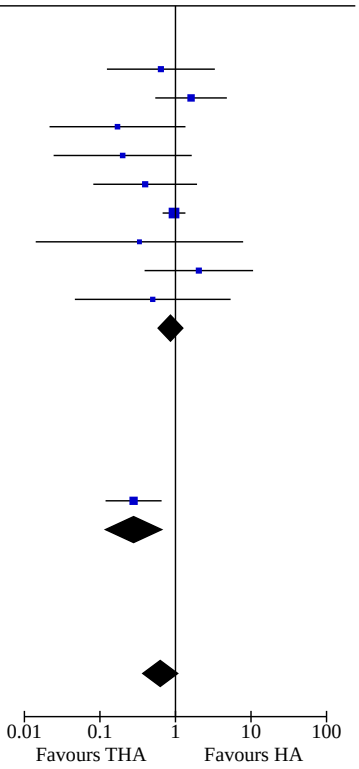


Footnotes

(1) THA: cemented, CPT stem, 28mm head, polyethylene cemented cup; HA: cemented, CPT stem, unipolar; at 39 months
(2) THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28 mm bipolar; at 48 months
(3) THS: described as Plus (DePuy) no other details reported; HA: described as a Merte HA no other details reported; at 48 months
(4) THA: cement, stem, head (≥ 28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 34 months
(5) THA: cemented, Weber or Muller stem, 32mm head, cup not reported; HA: cemented, Weber or Muller stem, bipolar; at 60 months
(6) THA: uncemented, Conus stem, large diameter head, polycarbonate-urethane cup; HA: mixed cemented and uncemented, Centrax stem, bipolar; at 36 mo
(7) THA: uncemented, various stem, but head and cup not reported; HA: uncemented; various stem; bipolar; at 60 months
(8) THA: cemented, Howse II stem, 32mm head, semicaptive cup; HA: uncemented, Austin-Moore, unipolar; at 13 years

Analysis 8.22. Comparison 8: THA vs HA, Outcome 22: Unplanned return to theatre (end of follow-up)

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
8.22.1 Modern design						
Dorr 1986 (1)	2	39	4	50	7.8%	0.64 [0.12 , 3.32]
Keating 2006 (2)	6	69	6	111	13.5%	1.61 [0.54 , 4.79]
Baker 2006 (3)	1	40	6	41	5.4%	0.17 [0.02 , 1.36]
Mouzopoulos 2008 (4)	1	43	5	43	5.3%	0.20 [0.02 , 1.64]
Van den Bekerom 2010 (5)	2	115	6	137	8.3%	0.40 [0.08 , 1.93]
HEALTH 2019 (6)	57	718	60	723	27.7%	0.96 [0.68 , 1.35]
Iorio 2019 (7)	0	30	1	30	2.6%	0.33 [0.01 , 7.87]
Parker 2019 (8)	4	52	2	53	7.8%	2.04 [0.39 , 10.65]
Chammout 2019 (9)	1	60	2	60	4.3%	0.50 [0.05 , 5.37]
Subtotal (95% CI)		**1166**		**1248**	**82.7%**	**0.86 [0.59 , 1.25]**
Total events:	74		92			
Heterogeneity: Tau² = 0.03; Chi² = 8.47, df = 8 (P = 0.39); I² = 6%						
Test for overall effect: Z = 0.80 (P = 0.43)						
8.22.2 First generation uncemented stem design						
Ravikumar 2000 (10)	6	89	22	91	17.3%	0.28 [0.12 , 0.66]
Subtotal (95% CI)		**89**		**91**	**17.3%**	**0.28 [0.12 , 0.66]**
Total events:	6		22			
Heterogeneity: Not applicable						
Test for overall effect: Z = 2.93 (P = 0.003)						
Total (95% CI)		**1255**		**1339**	**100.0%**	**0.63 [0.37 , 1.07]**
Total events:	80		114			
Heterogeneity: Tau² = 0.23; Chi² = 14.88, df = 9 (P = 0.09); I² = 40%						
Test for overall effect: Z = 1.72 (P = 0.09)						
Test for subgroup differences: Chi² = 5.58, df = 1 (P = 0.02), I² = 82.1%						



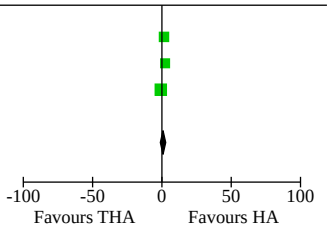
Footnotes

(1) THA: cemented, but stem, head and cup not reported; HA: cemented and uncemented, bipolar; at 48 months
(2) THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference, bipolar; at 24 months
(3) THA: cemented, CPT stem, 28mm head, polyethylene cemented cup; HA: cemented, CPT stem, unipolar; at 39 months
(4) THA: Plus DePuy, no details; HA: Metete; no details; at 48 months
(5) THA: cemented, 32mm head, no details for cup; HA: cemented, bipolar; at 60 months
(6) THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 24 months
(7) THA: uncemented, Pavistem, DMC; HA: cemented, Exciastem, bipolar; at 12 months
(8) THA: cemented; CPS and CPT stems, cemented 32mm polyethylene cups; HA: cemented, but various stem and heads; at 12 months
(9) Described as major reoperations; THA: cemented, CPT stem, 32mm head, cross linked polyethylene cup; HA: cemented, CPT stem, unipolar; at 24 montl
(10) THA: cemented, Howse II stem, 32mm head, semicaptive cup; HA: uncemented, Austin-Moore, unipolar; at 13 years

Analysis 8.23. Comparison 8: THA vs HA, Outcome 23: Length of hospital stay (days)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Mean Difference IV, Random, 95% CI
Keating 2006 (1)	12.3	10	69	10.8	7	111	30.9%	1.50 [-1.20 , 4.20]
Macaulay 2008 (2)	7.7	5.5	17	5.4	2.8	23	28.8%	2.30 [-0.55 , 5.15]
Mouzopoulos 2008 (3)	8.3	6.2	43	9.1	3.4	43	40.3%	-0.80 [-2.91 , 1.31]
Total (95% CI)			**129**			**177**	**100.0%**	**0.80 [-1.12 , 2.73]**

Heterogeneity: Tau² = 1.24; Chi² = 3.47, df = 2 (P = 0.18); I² = 42%
Test for overall effect: Z = 0.82 (P = 0.41)
Test for subgroup differences: Not applicable



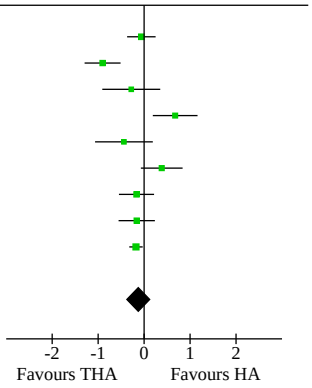
Footnotes

(1) THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference, bipolar
(2) THA: cement, stem, head (≥28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference
(3) THA: Plus DePuy, no details; HA: Metete; no details

Analysis 8.24. Comparison 8: THA vs HA, Outcome 24: Pain (12 months: data not combined; lower scores indicate less pain)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Std. Mean Difference IV, Random, 95% CI
Keating 2006 (1)	-20.9	5	66	-20.6	5	102	13.0%	-0.06 [-0.37 , 0.25]
Blomfeldt 2007 (2)	-43.1	2.3	56	-39.1	5.8	55	11.6%	-0.90 [-1.29 , -0.51]
Macaulay 2008 (3)	-92.5	14.6	17	-88.5	13.6	23	8.0%	-0.28 [-0.91 , 0.35]
Cadossi 2013 (4)	-39.5	5.56	36	-43.3	5.56	33	10.0%	0.68 [0.19 , 1.16]
Sonaje 2017 (5)	-41.6	2.01	20	-40.2	3.94	20	8.0%	-0.44 [-1.07 , 0.19]
Xu 2017 (6)	11.16	2.06	38	10.42	1.75	38	10.6%	0.38 [-0.07 , 0.84]
Chammout 2019 (7)	1.3	1.8	56	1.6	1.8	50	11.8%	-0.17 [-0.55 , 0.22]
Parker 2019 (8)	1.1	0.31	48	1.16	0.42	51	11.6%	-0.16 [-0.56 , 0.23]
HEALTH 2019 (9)	1.65	2.97	369	2.21	3.35	357	15.5%	-0.18 [-0.32 , -0.03]
Total (95% CI)			**706**			**729**	**100.0%**	**-0.13 [-0.38 , 0.12]**

Heterogeneity: Tau² = 0.10; Chi² = 32.05, df = 8 (P < 0.0001); I² = 75%
Test for overall effect: Z = 1.00 (P = 0.31)
Test for subgroup differences: Not applicable

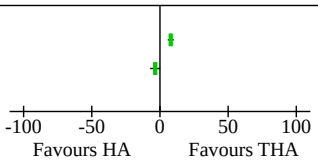


Footnotes

(1) Using Hip Rating Questionnaire (higher scores indicate less pain; we inverted this data in meta-analysis); THA: all cemented, but stem, head and cup surgeons preferenc
(2) HHS (higher scores indicate less pain; we inverted this data inverted in meta-analysis); THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modula
(3) WOMAC (pain on injured side. Higher scores indicate less pain; we inverted this data in meta-analysis); THA: cement, stem, head (≥ 28 mm) and cup all at surgeons pre
(4) HHS (higher scores indicate less pain; we inverted this data in meta-analysis); THA: uncemented, Conus stem, large diameter head, polycarbonate-urethane cup; HA: mi
(5) Pain domain of modified HHS (higher scores indicate less pain; we inverted this data in meta-analysis); THA: cemented, other details not reported; HA: cemented, bipol
(6) THA: uncemented, no other details; HA: uncemented, bipolar
(7) VAS (lower scores indicate less pain); HA: cemented, CPT stem, unipolar; THA: cemented, CPT stem, 32 mm head, cross-linked polyethylene cup; at 12 months
(8) Using 8-point pain scale (lower scores indicate less pain); THA: cemented; CPS and CPT stems, cemented 32 mm polyethylene cups; HA: cemented, but various stem ar
(9) Pain domain of WOMAC (lower scores indicate less pain); THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem and head all at surgeons prefe

Analysis 8.25. Comparison 8: THA vs HA, Outcome 25: Late pain (> 24 months)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Mean Difference IV, Fixed, 95% CI
Blomfeldt 2007 (1)	43	1.8	42	35.1	7	41	7.90 [5.69 , 10.11]
Cadossi 2013 (2)	40.5	5.33	16	44	5.33	16	-3.50 [-7.19 , 0.19]



Footnotes

(1) HHS (higher scores indicate less pain); THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28mm bipolar; at 48 months

(2) HHS (higher scores indicate less pain); THA: uncemented, Conus stem, large diameter head, polycarbonate-urethane cup; HA: mixed cemented and uncen

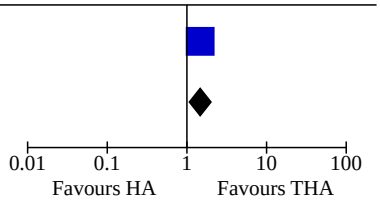
Analysis 8.26. Comparison 8: THA vs HA, Outcome 26: Pain (> 24 months: categorical data: no pain)

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Ravikumar 2000 (1)	46	69	30	66	100.0%	1.47 [1.07 , 2.00]
Total (95% CI)		**69**		**66**	**100.0%**	**1.47 [1.07 , 2.00]**
Total events:	46		30			

Heterogeneity: Not applicable

Test for overall effect: Z = 2.40 (P = 0.02)

Test for subgroup differences: Not applicable



Footnotes

(1) THA: cemented, Howse II stem, 32mm head, semicaptive cup; HA: uncemented, Austin-Moore, unipolar; at 13 years

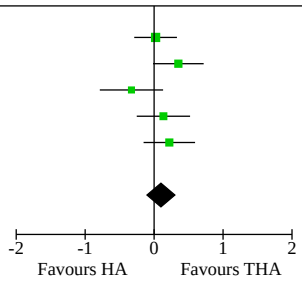
Analysis 8.27. Comparison 8: THA vs HA, Outcome 27: Early pain (≤ 4 months: higher scores indicate less pain)

Study or Subgroup	THA Mean	THA SD	THA Total	HA Mean	HA SD	HA Total	Weight	Std. Mean Difference IV, Random, 95% CI
Keating 2006 (1)	19.3	4	66	19.2	5	102	25.5%	0.02 [-0.29 , 0.33]
Blomfeldt 2007 (2)	42	4.5	58	40	6.6	58	20.5%	0.35 [-0.02 , 0.72]
Cadossi 2013 (3)	42	5.12	37	43.7	5.12	37	14.8%	-0.33 [-0.79 , 0.13]
Parker 2019 (4)	-1.3	0.51	51	-1.37	0.52	52	19.1%	0.13 [-0.25 , 0.52]
Chammout 2019 (5)	-1.9	1.7	57	-2.3	1.9	54	20.0%	0.22 [-0.15 , 0.59]
Total (95% CI)			**269**			**303**	**100.0%**	**0.10 [-0.10 , 0.30]**

Heterogeneity: Tau² = 0.02; Chi² = 5.84, df = 4 (P = 0.21); I² = 31%

Test for overall effect: Z = 0.96 (P = 0.34)

Test for subgroup differences: Not applicable



Footnotes

(1) Hip Rating Questionnaire (higher scores indicate less pain); THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preferenc

(2) HHS (higher scores indicate less pain); THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28 mm bipolar; at 4 months

(3) HHS (higher scores indicate less pain); THA: uncemented, Conus stem, large diameter head, polycarbonate-urethane cup; HA: mixed cemented and uncemented, Centra

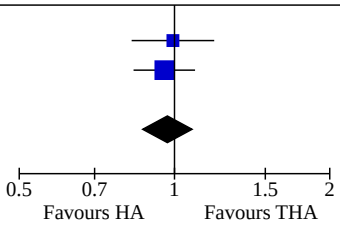
(4) Using 8-point pain scale (lower scores indicate less pain; we inverted the data in analysis). THA: cemented; CPS and CPT stems, cemented 32mm polyethylene cups; H

(5) VAS (lower scores indicate less pain; we inverted the data in meta-analysis); THA: cemented, CPT stem, 32mm head, cross linked polyethylene cup; HA: cemented, CP

Analysis 8.28. Comparison 8: THA vs HA, Outcome 28: Discharge destination (own home)

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
Keating 2006 (1)	50	69	81	111	35.7%	0.99 [0.83 , 1.19]
HEALTH 2019 (2)	253	713	267	719	64.3%	0.96 [0.83 , 1.10]
Total (95% CI)		**782**		**830**	**100.0%**	**0.97 [0.87 , 1.08]**
Total events:	303		348			

Heterogeneity: Tau² = 0.00; Chi² = 0.12, df = 1 (P = 0.73); I² = 0%
Test for overall effect: Z = 0.57 (P = 0.57)
Test for subgroup differences: Not applicable

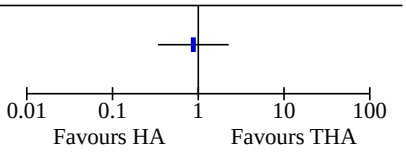


Footnotes

(1) THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference, bipolar
(2) Discharged to own home; THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference

Analysis 8.29. Comparison 8: THA vs HA, Outcome 29: Discharge destination (geriatric ward)

Study or Subgroup	HA Events	HA Total	THA Events	THA Total	Risk Ratio M-H, Fixed, 95% CI
Chammout 2019 (1)	7	60	8	60	0.88 [0.34 , 2.26]

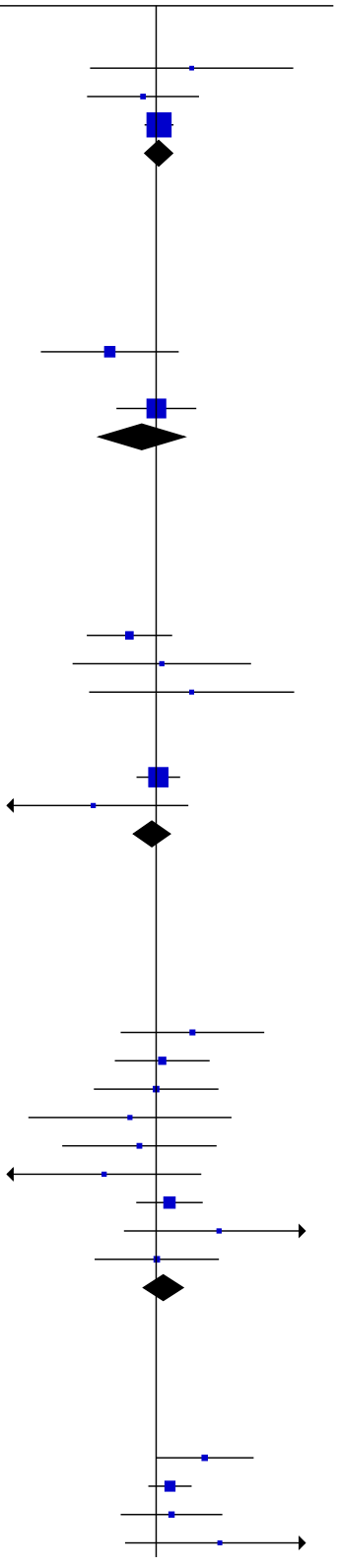


Footnotes

(1) Number not discharged to geriatric ward; THA: cemented, CPT stem, 32mm head, cross linked polyethylene cup; HA: cemented, CPT

Analysis 8.30. Comparison 8: THA vs HA, Outcome 30: Adverse events related to implant, fracture, or both

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
8.30.1 Postoperative perioprosthetic fracture						
Sonaje 2017 (1)	1	20	0	20	1.9%	3.00 [0.13 , 69.52]
Xu 2017 (2)	2	38	3	38	6.1%	0.67 [0.12 , 3.77]
HEALTH 2019 (3)	38	718	35	723	92.0%	1.09 [0.70 , 1.71]
Subtotal (95% CI)		**776**		**781**	**100.0%**	**1.08 [0.70 , 1.66]**
Total events:	41		38			
Heterogeneity: Tau² = 0.00; Chi² = 0.71, df = 2 (P = 0.70); I² = 0%						
Test for overall effect: Z = 0.35 (P = 0.72)						
8.30.2 Prosthetic loosening						
Blomfeldt 2007 (4)	0	60	0	60		Not estimable
Van den Bekerom 2010 (5)	1	115	5	137	31.5%	0.24 [0.03 , 2.01]
Xu 2017 (6)	0	38	0	38		Not estimable
HEALTH 2019 (3)	5	718	5	723	68.5%	1.01 [0.29 , 3.46]
Subtotal (95% CI)		**931**		**958**	**100.0%**	**0.64 [0.17 , 2.41]**
Total events:	6		10			
Heterogeneity: Tau² = 0.27; Chi² = 1.34, df = 1 (P = 0.25); I² = 25%						
Test for overall effect: Z = 0.66 (P = 0.51)						
8.30.3 Deep infection						
Dorr 1986 (7)	0	39	0	50		Not estimable
Ravikumar 2000 (8)	3	89	7	91	18.4%	0.44 [0.12 , 1.64]
Van den Bekerom 2010 (9)	1	115	1	137	4.2%	1.19 [0.08 , 18.84]
Sharma 2016 (10)	1	40	0	40	3.2%	3.00 [0.13 , 71.51]
Xu 2017 (6)	0	38	0	38		Not estimable
Parker 2019 (11)	0	52	0	53		Not estimable
HEALTH 2019 (3)	17	718	16	723	70.5%	1.07 [0.54 , 2.10]
Chammout 2019 (12)	0	60	3	60	3.7%	0.14 [0.01 , 2.71]
Subtotal (95% CI)		**1151**		**1192**	**100.0%**	**0.87 [0.50 , 1.54]**
Total events:	22		27			
Heterogeneity: Tau² = 0.00; Chi² = 3.51, df = 4 (P = 0.48); I² = 0%						
Test for overall effect: Z = 0.46 (P = 0.64)						
8.30.4 Superficial infection						
Dorr 1986 (7)	0	39	0	37		Not estimable
Baker 2006 (13)	3	40	1	41	7.6%	3.08 [0.33 , 28.34]
Keating 2006 (14)	3	69	4	111	17.5%	1.21 [0.28 , 5.23]
Blomfeldt 2007 (4)	2	60	2	60	10.1%	1.00 [0.15 , 6.87]
Macaulay 2008 (15)	0	17	1	23	3.8%	0.44 [0.02 , 10.29]
Van den Bekerom 2010 (9)	1	115	2	137	6.6%	0.60 [0.05 , 6.49]
Sharma 2016 (10)	0	40	2	40	4.2%	0.20 [0.01 , 4.04]
HEALTH 2019 (3)	9	718	6	723	35.6%	1.51 [0.54 , 4.22]
Chammout 2019 (12)	3	60	0	60	4.3%	7.00 [0.37 , 132.66]
Parker 2019 (11)	2	52	2	53	10.2%	1.02 [0.15 , 6.97]
Subtotal (95% CI)		**1210**		**1285**	**100.0%**	**1.25 [0.67 , 2.30]**
Total events:	23		20			
Heterogeneity: Tau² = 0.00; Chi² = 4.39, df = 8 (P = 0.82); I² = 0%						
Test for overall effect: Z = 0.70 (P = 0.48)						
8.30.5 Dislocation						
Dorr 1986 (16)	7	39	2	50	9.6%	4.49 [0.99 , 20.41]
Ravikumar 2000 (17)	18	89	12	91	30.0%	1.53 [0.79 , 3.00]
Keating 2006 (14)	3	69	3	111	9.1%	1.61 [0.33 , 7.75]
Baker 2006 (18)	3	40	0	41	2.9%	7.17 [0.38 , 134.53]

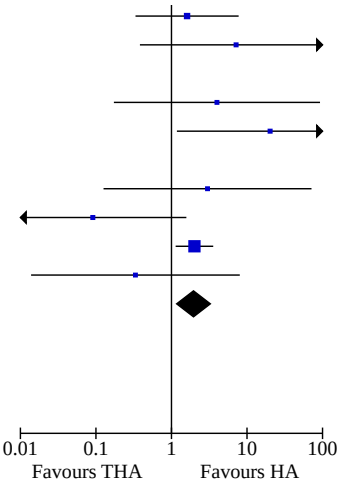


Analysis 8.30. (Continued)

Keating 2006 (14)	3	69	3	111	9.1%	1.61 [0.33 , 7.75]
Baker 2006 (18)	3	40	0	41	2.9%	7.17 [0.38 , 134.53]
Blomfeldt 2007 (4)	0	60	0	60		Not estimable
Macaulay 2008 (15)	1	17	0	23	2.6%	4.00 [0.17 , 92.57]
Van den Bekerom 2010 (19)	8	115	0	137	3.1%	20.22 [1.18 , 346.66]
Sharma 2016 (10)	0	40	0	40		Not estimable
Xu 2017 (6)	1	38	0	38	2.5%	3.00 [0.13 , 71.40]
Iorio 2019 (20)	0	30	5	30	3.1%	0.09 [0.01 , 1.57]
HEALTH 2019 (3)	34	718	17	723	34.7%	2.01 [1.14 , 3.57]
Chammout 2019 (12)	0	60	1	60	2.5%	0.33 [0.01 , 8.02]
Subtotal (95% CI)		**1315**		**1404**	**100.0%**	**1.96 [1.17 , 3.27]**
Total events:	75		40			

Heterogeneity: Tau² = 0.11; Chi² = 10.98, df = 9 (P = 0.28); I² = 18%

Test for overall effect: Z = 2.57 (P = 0.01)

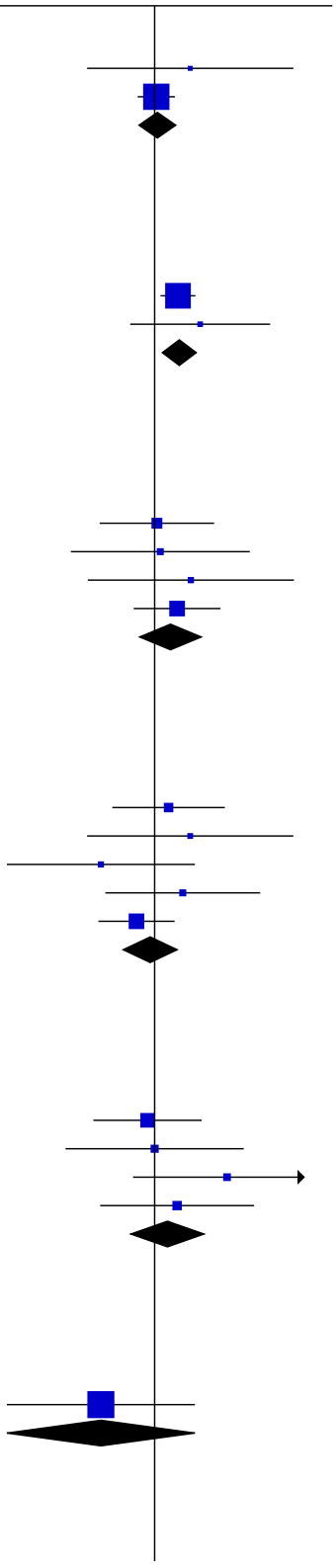


Footnotes

(1) THA: cemented, other details not reported; HA1: cemented, bipolar; at 24 months
(2) THA: uncemented, no other details; HA: uncemented, bipolar; at 60 months
(3) THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 24 months
(4) THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28mm bipolar; at 12 months
(5) THA: cemented, Weber or Muller stem, 32mm head, cup not reported; HA: cemented, Weber or Muller stem, bipolar; at 5 years
(6) THA: uncemented, no other details; HA: uncemented, bipolar; at 60 months
(7) THA: cemented, but stem, head and cup not reported; HA: cemented, bipolar; at 24 months
(8) Includes data for superficial and deep infection; THA: cemented, Howse II stem, 32mm head, semicaptive cup; HA: uncemented, Austin-Moore, unipolar
(9) THA: cemented, Weber or Muller stem, 32 mm head, cup not reported; HA: cemented, Weber or Muller stem, bipolar; at 12 months
(10) THA: details not reported; HA: details not reported; at 1 week
(11) THA: cemented; CPS and CPT stems, cemented 32mm polyethylene cups; HA: cemented, but various stem and heads; at 12 months
(12) THA: cemented, CPT stem, 32mm head, cross linked polyethylene cup; HA: cemented, CPT stem, unipolar; at 24 months
(13) THA: cemented, CPT stem, 28mm head, polyethylene cemented cup; HA: cemented, CPT stem, unipolar; at 39 months
(14) THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference, bipolar; at 24 months
(15) THA: cement, stem, head (≥28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 6 months
(16) THA: cemented, but stem, head and cup not reported; HA: cemented and uncemented, bipolar; at 48 months
(17) THA: cemented, Howse II stem, 32mm head, semicaptive cup; HA: uncemented, Austin-Moore, unipolar; at 13 years
(18) THA: cemented, CPT stem, 28mm head, polyethylene cemented cup; HA: cemented, CPT stem, unipolar; at 30 days
(19) THA: cemented, 32mm head, no details for cup; HA: cemented, bipolar; at 60 months
(20) THA: uncemented, Pavistem, DMC; HA: cemented, Exciastem, bipolar; at 12 months

Analysis 8.31. Comparison 8: THA vs HA, Outcome 31: Adverse events unrelated to implant, fracture, or both

Study or Subgroup	THA Events	THA Total	HA Events	HA Total	Weight	Risk Ratio M-H, Random, 95% CI
8.31.1 Acute kidney injury						
Chammout 2019 (1)	1	60	0	60	3.2%	3.00 [0.12 , 72.20]
HEALTH 2019 (2)	23	718	22	723	96.8%	1.05 [0.59 , 1.87]
Subtotal (95% CI)		**778**		**783**	**100.0%**	**1.09 [0.62 , 1.92]**
Total events:	24		22			
Heterogeneity: Tau² = 0.00; Chi² = 0.40, df = 1 (P = 0.53); I² = 0%						
Test for overall effect: Z = 0.29 (P = 0.77)						
8.31.2 Blood transfusion						
Keating 2006 (3)	23	69	18	111	94.1%	2.06 [1.20 , 3.52]
Parker 2019 (4)	4	52	1	53	5.9%	4.08 [0.47 , 35.27]
Subtotal (95% CI)		**121**		**164**	**100.0%**	**2.14 [1.27 , 3.61]**
Total events:	27		19			
Heterogeneity: Tau² = 0.00; Chi² = 0.37, df = 1 (P = 0.54); I² = 0%						
Test for overall effect: Z = 2.85 (P = 0.004)						
8.31.3 Cerebrovascular accident						
Keating 2006 (3)	2	69	3	111	29.0%	1.07 [0.18 , 6.26]
Van den Bekerom 2010 (5)	1	115	1	137	11.8%	1.19 [0.08 , 18.84]
Parker 2019 (6)	1	52	0	53	8.9%	3.06 [0.13 , 73.36]
Chammout 2019 (1)	6	60	3	60	50.3%	2.00 [0.52 , 7.63]
Subtotal (95% CI)		**296**		**361**	**100.0%**	**1.63 [0.63 , 4.21]**
Total events:	10		7			
Heterogeneity: Tau² = 0.00; Chi² = 0.51, df = 3 (P = 0.92); I² = 0%						
Test for overall effect: Z = 1.01 (P = 0.31)						
8.31.4 Pneumonia/chest infection (reported at > 4 months)						
Baker 2006 (7)	3	40	2	41	22.9%	1.54 [0.27 , 8.72]
Blomfeldt 2007 (8)	1	60	0	60	6.8%	3.00 [0.12 , 72.20]
Macaulay 2008 (9)	0	17	3	23	8.2%	0.19 [0.01 , 3.46]
Van den Bekerom 2010 (5)	2	115	1	137	12.1%	2.38 [0.22 , 25.94]
Chammout 2019 (1)	4	60	7	60	50.0%	0.57 [0.18 , 1.85]
Subtotal (95% CI)		**292**		**321**	**100.0%**	**0.87 [0.38 , 2.00]**
Total events:	10		13			
Heterogeneity: Tau² = 0.00; Chi² = 3.23, df = 4 (P = 0.52); I² = 0%						
Test for overall effect: Z = 0.32 (P = 0.75)						
8.31.5 Myocardial infarction						
Keating 2006 (3)	2	69	4	111	45.5%	0.80 [0.15 , 4.28]
Blomfeldt 2007 (8)	1	60	1	60	16.8%	1.00 [0.06 , 15.62]
Macaulay 2008 (9)	3	17	0	23	15.1%	9.33 [0.51 , 169.54]
Chammout 2019 (1)	2	60	1	60	22.5%	2.00 [0.19 , 21.47]
Subtotal (95% CI)		**206**		**254**	**100.0%**	**1.48 [0.48 , 4.58]**
Total events:	8		6			
Heterogeneity: Tau² = 0.00; Chi² = 2.27, df = 3 (P = 0.52); I² = 0%						
Test for overall effect: Z = 0.69 (P = 0.49)						
8.31.6 Urinary tract infection						
Macaulay 2008 (10)	0	17	3	23	100.0%	0.19 [0.01 , 3.46]
Subtotal (95% CI)		**17**		**23**	**100.0%**	**0.19 [0.01 , 3.46]**
Total events:	0		3			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.12 (P = 0.26)						



Analysis 8.31. (Continued)

Test for overall effect: Z = 1.12 (P = 0.26)

8.31.7 Venous thromboembolic phenomena (DVT)

Baker 2006 (11)	4	40	0	41	26.6%	9.22 [0.51 , 165.87]
Keating 2006 (3)	4	69	0	111	26.3%	14.40 [0.79 , 263.40]
Blomfeldt 2007 (8)	0	60	1	60	22.4%	0.33 [0.01 , 8.02]
Parker 2019 (6)	2	52	0	53	24.7%	5.09 [0.25 , 103.62]
Subtotal (95% CI)		**221**		**265**	**100.0%**	**4.25 [0.86 , 21.06]**
Total events:	10		1			

Heterogeneity: Tau² = 0.34; Chi² = 3.43, df = 3 (P = 0.33); I² = 13%

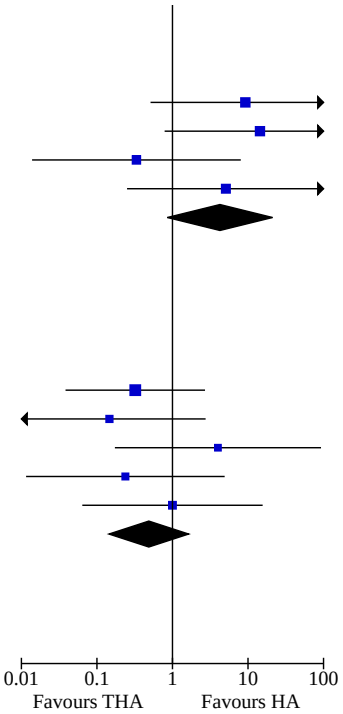
Test for overall effect: Z = 1.77 (P = 0.08)

8.31.8 Venous thromboembolic phenomena (pulmonary embolism)

Keating 2006 (3)	1	69	5	111	32.5%	0.32 [0.04 , 2.70]
Baker 2006 (11)	0	40	3	41	17.1%	0.15 [0.01 , 2.75]
Macaulay 2008 (9)	1	17	0	23	14.9%	4.00 [0.17 , 92.57]
Van den Bekerom 2010 (5)	0	115	2	137	16.0%	0.24 [0.01 , 4.91]
Chammout 2019 (1)	1	60	1	60	19.5%	1.00 [0.06 , 15.62]
Subtotal (95% CI)		**301**		**372**	**100.0%**	**0.49 [0.14 , 1.63]**
Total events:	3		11			

Heterogeneity: Tau² = 0.00; Chi² = 3.01, df = 4 (P = 0.56); I² = 0%

Test for overall effect: Z = 1.17 (P = 0.24)



Footnotes

(1) THA: cemented, CPT stem, 32mm head, cross linked polyethylene cup; HA: cemented, CPT stem, unipolar; at 24 months
(2) THA: cement, stem, head and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 24 months
(3) THA: all cemented, but stem, head and cup surgeons preference; HA: all cemented, stem surgeons preference, bipolar; at 24 months
(4) THA: cemented; CPS and CPT stems, cemented 32mm polyethylene cups; HA: cemented, but various stem and heads; at 12 months
(5) THA: cemented, Weber or Muller stem, 32 mm head, cup not reported; HA: cemented, Weber or Muller stem, bipolar; at 12 months
(6) THA: cemented; CPS and CPT stems, cemented 32mm polyethylene cups; HA: cemented, but various stem and heads; at 12 months
(7) THA: cemented, CPT stem, 28mm head, polyethylene cemented cup; HA: cemented, CPT stem, unipolar; at 30 days
(8) THA: cemented, Exeter modular, OGEE (DePuy); HA: cemented, Exeter modular, 28mm bipolar; at 4 months
(9) THA: cement, stem, head (≥28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 6 months
(10) THA: cement, stem, head (≥ 28 mm) and cup all at surgeons preference; HA: cement, stem and head all at surgeons preference; at 24 months
(11) THA: cemented, CPT stem, 28mm head, polyethylene cemented cup; HA: cemented, CPT stem, unipolar; at 30 days

Comparison 9. THA: single articulation vs dual-mobility

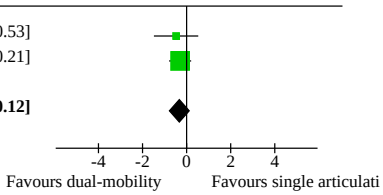
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
9.1 Early functional status (≤ 4 months, using different scales; higher scores indicate better function)	2	78	Std. Mean Difference (IV, Random, 95% CI)	-0.33 [-0.78, 0.12]
9.2 Functional status (12 months, using OHS and HHS; higher scores indicate better function)	2	79	Std. Mean Difference (IV, Random, 95% CI)	-0.60 [-1.05, -0.15]
9.3 HRQoL (using EQ-5D, range of scores from 0 to 1; higher scores indicate better quality of life)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
9.3.1 Early (≤ 4 months)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
9.3.2 At 12 months	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
9.4 Mortality (12 months)	2	82	Risk Ratio (M-H, Random, 95% CI)	0.62 [0.08, 4.77]
9.5 Adverse events related to the implant, fracture, or both	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
9.5.1 Deep infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
9.5.2 Superficial infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
9.5.3 Dislocation	2		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
9.6 Adverse events unrelated to the implant, fracture, or both	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
9.6.1 Venous thromboembolic phenomena	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Analysis 9.1. Comparison 9: THA: single articulation vs dual-mobility, Outcome 1: Early functional status (≤ 4 months, using different scales; higher scores indicate better function)

	Single articulation			Dual-mobility				Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Griffin 2016 (1)	12	9.8	7	17.1	10.3	9	19.9%	-0.48 [-1.48 , 0.53]	
Rashed 2020 (2)	82.27	11.3685	31	86.46	16.2485	31	80.1%	-0.30 [-0.80 , 0.21]	
Total (95% CI)			**38**			**40**	**100.0%**	**-0.33 [-0.78 , 0.12]**	

Heterogeneity: Tau² = 0.00; Chi² = 0.10, df = 1 (P = 0.75); I² = 0%
Test for overall effect: Z = 1.45 (P = 0.15)
Test for subgroup differences: Not applicable

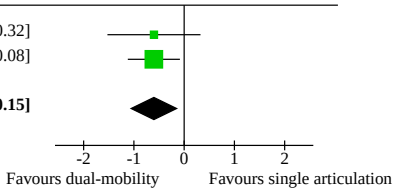


Footnotes
(1) Oxford hip score (higher scores indicate better mobility); THA1: standard bearing selected by surgeon; THA2: uncemented Novae DM acetabular component; at 4 months
(2) HHS; single articulation THA vs dual-mobility THA; at 4 months

Analysis 9.2. Comparison 9: THA: single articulation vs dual-mobility, Outcome 2: Functional status (12 months, using OHS and HHS; higher scores indicate better function)

Study or Subgroup	Single articulation Mean	SD	Total	Dual-mobility Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Griffin 2016 (1)	6.3	7.5	9	12.4	11.3	10	23.9%	-0.60 [-1.53 , 0.32]
Rashed 2020 (2)	86.62	7.2843	30	92.8	12.319	30	76.1%	-0.60 [-1.12 , -0.08]
Total (95% CI)			**39**			**40**	**100.0%**	**-0.60 [-1.05 , -0.15]**

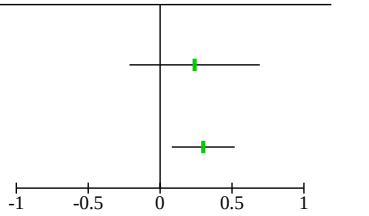
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 1.00); I² = 0%
Test for overall effect: Z = 2.61 (P = 0.009)
Test for subgroup differences: Not applicable



Footnotes
(1) Oxford hip score; THA1: uncemented Novae DM acetabular component; THA2: standard bearing selected by surgeon; at 12 months
(2) HHS; DMC vs standard THA; at 12 months

Analysis 9.3. Comparison 9: THA: single articulation vs dual-mobility, Outcome 3: HRQoL (using EQ-5D, range of scores from 0 to 1; higher scores indicate better quality of life)

Study or Subgroup	Single articulation Mean	SD	Total	Dual-mobility Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
9.3.1 Early (≤ 4 months)							
Griffin 2016 (1)	0.59	0.5	7	0.35	0.4	9	0.24 [-0.21 , 0.69]
9.3.2 At 12 months							
Griffin 2016 (2)	0.84	0.16	9	0.54	0.31	10	0.30 [0.08 , 0.52]

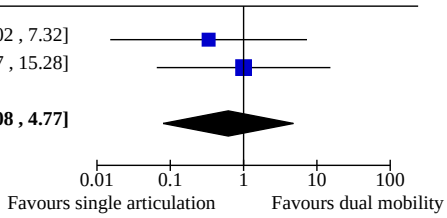


Footnotes
(1) EQ-5D (higher scores indicate better quality of life). THA1: uncemented Novae DM acetabular component; THA2: standard bearing selected by surgeon
(2) EQ-5D; THA1: uncemented Novae DM acetabular component; THA2: standard bearing selected by surgeon; at 12 months

Analysis 9.4. Comparison 9: THA: single articulation vs dual-mobility, Outcome 4: Mortality (12 months)

Study or Subgroup	Single articulation Events	Total	Dual-mobility Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Griffin 2016 (1)	0	10	1	10	43.8%	0.33 [0.02 , 7.32]
Rashed 2020 (2)	1	31	1	31	56.2%	1.00 [0.07 , 15.28]
Total (95% CI)		**41**		**41**	**100.0%**	**0.62 [0.08 , 4.77]**
Total events:	1		2			

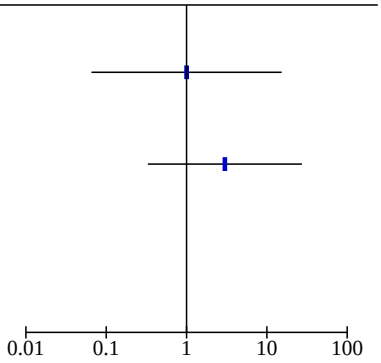
Heterogeneity: Tau² = 0.00; Chi² = 0.27, df = 1 (P = 0.60); I² = 0%
Test for overall effect: Z = 0.46 (P = 0.64)
Test for subgroup differences: Not applicable



Footnotes
(1) THA1: uncemented Novae DM acetabular component; THA2: standard bearing selected by surgeon; at 12 months
(2) THA1: cemented, 32mm head, DMC; THA2: cemented, conventional large head 32 mm; at 12 months

Analysis 9.5. Comparison 9: THA: single articulation vs dual-mobility, Outcome 5: Adverse events related to the implant, fracture, or both

Study or Subgroup	Single articulation Events	Total	Dual-mobility Events	Total	Risk Ratio M-H, Fixed, 95% CI
9.5.1 Deep infection					
Rashed 2020 (1)	1	31	1	31	1.00 [0.07 , 15.28]
9.5.2 Superficial infection					
Rashed 2020 (1)	3	31	1	31	3.00 [0.33 , 27.29]
9.5.3 Dislocation					
Rashed 2020 (2)	0	31	0	31	Not estimable
Griffin 2016 (3)	0	10	0	10	Not estimable



Footnotes

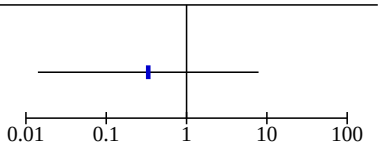
(1) THA1: cemented, 32mm head, DMC; THA2: cemented, conventional large head 32 mm; at 12 months

(2) DMC vs conventional; at 12 months

(3) DMC vs standard (selected by surgeon); at 12 months

Analysis 9.6. Comparison 9: THA: single articulation vs dual-mobility, Outcome 6: Adverse events unrelated to the implant, fracture, or both

Study or Subgroup	Single articulation Events	Total	Dual-mobility Events	Total	Risk Ratio M-H, Fixed, 95% CI
9.6.1 Venous thromboembolic phenomena					
Rashed 2020 (1)	0	31	1	31	0.33 [0.01 , 7.88]



Footnotes

(1) DVT; THA1: cemented, 32mm head, DMC; THA2: cemented, conventional large head 32 mm; at 12 months

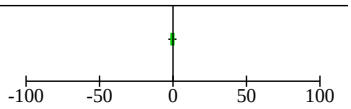
Comparison 10. THA: short stem vs standard stem

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
10.1 Functional status (at 24 months; using HHS, range of scores from 0 to 100; higher scores indicate better function)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
10.2 Mobility	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.3 Mortality (12 months)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.4 Pain	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
10.5 Adverse events related to the implant, fracture, or both	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.5.1 Intraoperative periprosthetic fracture	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.5.2 Superficial infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.5.3 Dislocation	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.6 Adverse events unrelated to the implant, fracture, or both	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.6.1 Acute kidney injury	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.6.2 Chest infection/pneumonia	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
10.6.3 Urinary tract infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Analysis 10.1. Comparison 10: THA: short stem vs standard stem, Outcome 1: Functional status (at 24 months; using HHS, range of scores from 0 to 100; higher scores indicate better function)

	Short stem			Standard stem			Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	IV, Fixed, 95% CI	IV, Fixed, 95% CI
Kim 2012 (1)	85.7	8.89	70	86.1	7.912	70	-0.40 [-3.19 , 2.39]	

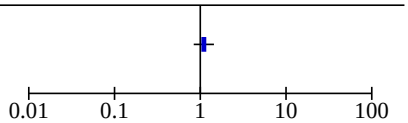


Footnotes

(1) HHS; THA1: uncemented, short, anatomical metaphyseal-fitting, 36 mm Biolox delta ceramic modular head, cementless acetabular component; THA2: uncen

Analysis 10.2. Comparison 10: THA: short stem vs standard stem, Outcome 2: Mobility

	Short stem		Standard stem		Risk Ratio	Risk Ratio
Study or Subgroup	Events	Total	Events	Total	M-H, Fixed, 95% CI	M-H, Fixed, 95% CI
Kim 2012 (1)	44	70	40	70	1.10 [0.84 , 1.44]	

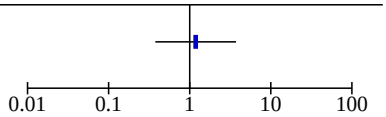


Footnotes

(1) Walks > 6 blocks with or without aid; THA1: uncemented, short, anatomical metaphyseal-fitting, 36 mm Biolox delta ceramic modular

Analysis 10.3. Comparison 10: THA: short stem vs standard stem, Outcome 3: Mortality (12 months)

Study or Subgroup	Short stem Events	Short stem Total	Standard stem Events	Standard stem Total	Risk Ratio M-H, Fixed, 95% CI
Kim 2012 (1)	6	81	5	80	1.19 [0.38 , 3.73]

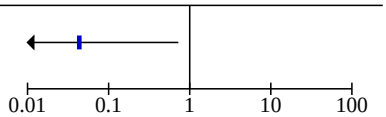


Footnotes

(1) Short stem vs conventional; THA1: uncemented, short, anatomical metaphyseal-fitting, 36 mm Biolox delta ceramic modular head, cementless

Analysis 10.4. Comparison 10: THA: short stem vs standard stem, Outcome 4: Pain

Study or Subgroup	Short stem Events	Short stem Total	Standard stem Events	Standard stem Total	Risk Ratio M-H, Fixed, 95% CI
Kim 2012 (1)	0	70	11	70	0.04 [0.00 , 0.72]

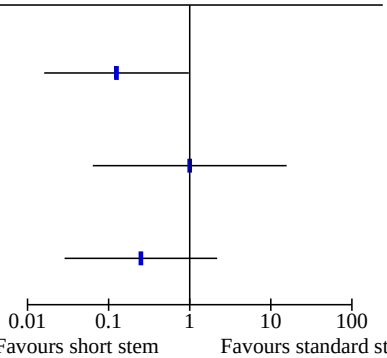


Footnotes

(1) Number experiencing thigh pain; THA1: uncemented, short, anatomical metaphyseal-fitting, 36 mm Biolox delta ceramic modular head, ceme

Analysis 10.5. Comparison 10: THA: short stem vs standard stem, Outcome 5: Adverse events related to the implant, fracture, or both

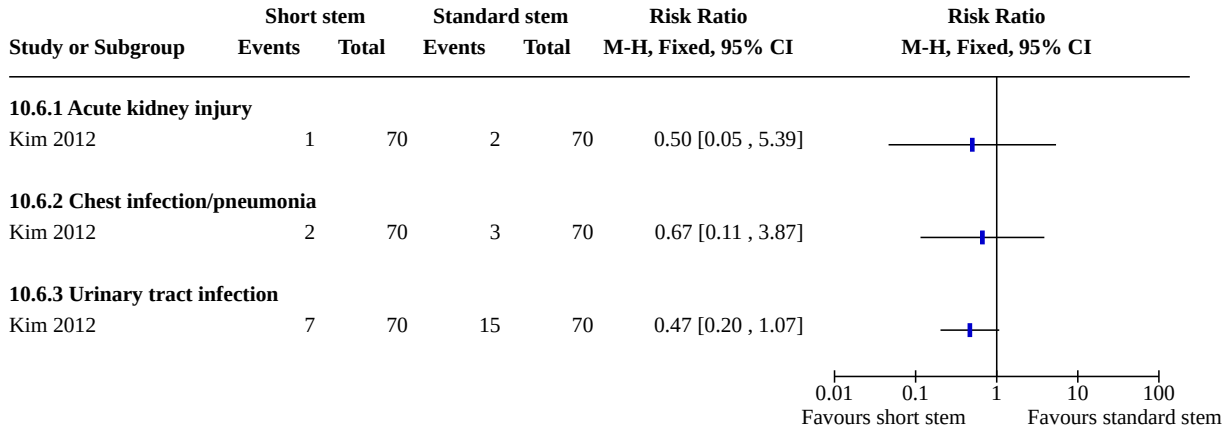
Study or Subgroup	Short stem Events	Short stem Total	Standard stem Events	Standard stem Total	Risk Ratio M-H, Fixed, 95% CI
10.5.1 Intraoperative periprosthetic fracture					
Kim 2012 (1)	1	70	8	70	0.13 [0.02 , 0.97]
10.5.2 Superficial infection					
Kim 2012	1	70	1	70	1.00 [0.06 , 15.67]
10.5.3 Dislocation					
Kim 2012	1	70	4	70	0.25 [0.03 , 2.18]



Footnotes

(1) THA1: uncemented, short, anatomical metaphyseal-fitting, 36 mm Biolox delta ceramic modular head, cementless acetabular component; THA

Analysis 10.6. Comparison 10: THA: short stem vs standard stem, Outcome 6: Adverse events unrelated to the implant, fracture, or both



ADDITIONAL TABLES

Table 1. Trochanteric region fractures: type and surgical management (revised AO/OTA classification, January 2018)

Type	Features	Stability	Description
Simple, pertrochanteric fractures (A1)	• Isolated pertrochanteric fracture • 2-part fracture • Lateral wall intact	Stable	The fracture line can begin anywhere on the greater trochanter and end either above or below the lesser trochanter. The medial cortex is interrupted in only 1 place.
Multifragmentary pertrochanteric fractures (A2)	• With 1 or more intermediate fragments • Lateral wall may be incompetent	Unstable	The fracture line can start laterally anywhere on the greater trochanter and runs towards the medial cortex which is typically broken in 2 places. This can result in the detachment of a third fragment which may include the lesser trochanter.
Intertrochanteric fractures (A3)	• Simple oblique fracture • Simple transverse fracture • Wedge or multifragmentary fracture	Unstable	The fracture line passes between the 2 trochanters, above the lesser trochanter medially and below the crest of the vastus lateralis laterally.

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

Table 2. Proposed grouping of different types of arthroplasty for hip fracture in adults

Implant category	Variable (articulation/fixation technique)	Implant subcategory	Examples[a]	Description
Total hip arthroplasty	Articulation	Femoral head and acetabular	• Metal-on-polyethylene (MoP)	Bearing surfaces may be grouped into hard (ceramic and metal) and soft (polyethylene variants).

Table 2. Proposed grouping of different types of arthroplasty for hip fracture in adults *(Continued)*

		bearing surface materials	• Ceramic-on-polyethylene (CoP) • Ceramic-on-ceramic (CoC) • Metal-on-metal (MoM) • Polyethylene material • Highly cross-linked (HCL) • Not HCL	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 THA 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 polymethylmethacrylate bone cement that is inserted at the time of surgery. It sets hard and acts a 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 similarly 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	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.

Table 2. Proposed grouping of different types of arthroplasty for hip fracture in adults *(Continued)*

			• Endo Femoral Head • CPT Zimmer • Unitrax	
		Bipolar	• CPT modular bipolar • Exeter modular bipolar • 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 to 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 polymethylmethacrylate 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 polymethylmethacrylate bone cement that is inserted at the time of surgery. It sets hard and acts a 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 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.

[a]This list is not exhaustive.
Abbreviations:
CoC: Ceramic-on-ceramic
CoP: Ceramic-on-polyethylene
CPT: collarless polished tapered
HCL: Highly cross-linked
MoM: Metal-on-metal
MoP: Metal-on-polyethylene
THA: total hip arthroplasty

Table 3. Implant and study characteristics. Prostheses implanted with cement versus without cement

Study ID	Type of cemented implant Type of uncemented implant	Study design (N)	Displaced fractures, %	Critical review outcomes (time point, n)
Brandfoot 2000	1. Cemented, Thompson, unipolar	RCT (91)	98	Mortality (16 months, 91)

Table 3. Implant and study characteristics. Prostheses implanted with cement versus without cement *(Continued)*

	2. Uncemented Thompson, unipolar			
Cao 2017	1. Cemented, stem type and uni/bipolar NR 2. Uncemented, stem type and uni/bipolar NR	RCT (85)	NR	Function (3 and 6 months, 85)
Chammout 2017	1. Cemented, modular CPT, 32 mm head, cemented cup 2. Uncemented, Bi-Metric stem, 32 mm head, cemented cup	RCT (69)	100	ADL (3 months, 65; 24 months, 59) Function (24 months, 65) HRQoL (3 months, 64; 12 months, 62) Mortality (12 months, 69) Unplanned return to theatre (24 months, 69)
DeAngelis 2012	1. Cemented, VerSys stem, unipolar 2. Uncemented, beaded stem, unipolar	RCT (130)	100	Unplanned return to theatre (12 months, 130)
Emery 1991	1. Cemented, Thompson, bipolar 2. Uncemented, Moore, bipolar	RCT (53)	100	Mobility (3 months, 39) Mortality (3 and 17/18 months, 53)
Figved 2009	1. Cemented, Spectron, bipolar 2. Uncemented, Corail, bipolar	RCT (230 fractures, 223 participants)	100	ADL (3 months, 190; 12 months, 168) Function (3 months, 189; 12 months, 167) HRQoL (3 months, 143; 12 months, 113) Mobility (3 months, 190; 12 months, 168) Mortality (3 and 12 months, 213) Unplanned return to theatre (12 months, 217)
Harper 1994	1. Cemented, Thompson, unipolar 2. Uncemented, Thompson, unipolar	RCT (137)	100	Mortality (3 and 12 months, 137)
Inngul 2015	1. Cemented, Exeter stem, unipolar or 32mm, cemented cross-linked polyethylene cup 2. Uncemented, HAC Bimetric stem, unipolar or 32 mm, cemented cross-linked polyethylene cup	RCT (141)	100	Mortality (4 and 12 months, 141) Unplanned return to theatre (12 months, 141)

Table 3. Implant and study characteristics. Prostheses implanted with cement versus without cement *(Continued)*

Moerman 2017	1. Cemented, Muller, bi/unipolar NR 2. Uncemented, DB10, bi/unipolar NR	RCT (201)	100	ADL (3 months, 114; 12 months, 96) HRQoL (3 months, 102; 12 months, 90) Mobility (3 months, 88; 12 months, 74) Mortality (12 months, 201) Unplanned return to theatre (12 months, 201)
Moroni 2002	1. Cemented, AHS prosthesis, unipolar or THA 2. Uncemented (HAC), Furlong, unipolar or THA	RCT (28)	NR	Function (24 months, 28) HRQoL (24 months, 28) Mortality (24 months, 28)
Movrin 2020	1. Cemented, Muller, bi/unipolar NR 2. Uncemented, DB10, bi/unipolar NR	RCT (158)	100	Function (3 month, 148; 24 months, 94) Mortality (7 days and 24 months, 158)
Parker 2010c	1. Cemented, Thompson, unipolar 2. Uncemented, Moore, unipolar	RCT (400)	100	Delirium (60 months, 400) Mobility (3 months, 327; 60 months, 64) Mortality (12 and 60 months, 400) Unplanned return to theatre (60 months, 400)
Parker 2020	1. Cemented, Exeter Trauma or CPT, unipolar 2. Uncemented, Furlong, unipolar	RCT (400)	100	ADL (4 months, 329; 12 months 283) Delirium (12 months, 400) Mobility (3 months, 329; 12 months, 282) Mortality (3 and 12 months, 400)
Rehman 2014	1. Cemented, Thompson, unipolar 2. Uncemented, Moore, unipolar	RCT (110)	100	Mobility (3 months, 110)
Sadr 1977	1. Cemented, Thompson, unipolar 2. Uncemented, Thompson, unipolar	RCT (40)	100	Function (17 months, 25) Mortality (6 weeks and 12 months, 40)
Santini 2005	1. Cemented, stem type NR, unipolar 2. Uncemented, stem type NR, unipolar	RCT (106)	NR	ADL (12 months, 106) Function (12 months, 106) Mobility (unknown time point, 106)

Table 3. Implant and study characteristics. Prostheses implanted with cement versus without cement *(Continued)*

				Mortality (at hospital discharge and 12 months, 106)
Sonne-Holm 1982	1. Cemented, Moore, unipolar 2. Uncemented, Moore, unipolar	RCT (112)	NR	Function (3 and 12 months, 75) Mobility (3 and 12 months, 75) Mortality (6 weeks, 112)
Talsnes 2013	1. Cemented, Landos Titan, bipolar 2. Uncemented, Landos Corail, bipolar	RCT (334)	100	Mortality (12 months, 334)
Taylor 2012	1. Cemented, Exeter, unipolar 2. Uncemented, Zweymuller Alloclassic, unipolar	RCT (160)	100	Mortality (6 weeks and 12 months, 160) Unplanned return to theatre (24 months, 160)
Vidovic 2013	1. Cemented, modular, unipolar 2. Uncemented, Moore, unipolar	RCT (79)	100	Function (3 months, 79; 12 months, 60) Mortality (12 months, 79)
Fernandez 2022	1.Cemented HA, stem and- head at surgeon's preference 2.Uncemented HA, stem and- head at surgeon's preference	RCT (1225)	99	ADL (4 months, 715; 12 months, 580) HRQoL (4 months, 877; 12 months, 876) Mobility (4 months, 715; 12 months, 583) HRQoL (4 months, 877; 12 months, 876) Unplanned return to theatre (12 months, 1225) Mortality (12 months, 1225)

ADL: activities of daily living
AHS: manufacturer's name for implant
CPT: collarless, polished, double-taper design concept
DB: manufacturer's name for implant
HAC: hydroxyapatite-coated
HRQoL: health-related quality of life
N: total number randomised
n: number analysed
NR: not reported
RCT: randomised controlled trial

Table 4. Implant and study characteristics. Bipolar HA versus unipolar HA

Study ID	Type of HA bipolar Type of HA unipolar	Study design (N)	Displaced fractures, %	Critical review outcomes (time point, n)

Table 4. Implant and study characteristics. Bipolar HA versus unipolar HA *(Continued)*

Abdelkhalek 2011	1. Mixed cemented/uncemented, bipolar; 2. Mixed cemented/uncemented, unipolar	Quasi RCT (50)	100	Function (4.4 years, 50) Unplanned return to theatre (24 months, 50)
Calder 1995	1. Monk, cemented, bipolar 2. Thompson, cemented, unipolar	RCT (73)	100	Pain (6 months, 73) Mobility (6 months, 73)
Calder 1996	1. Monk, cemented, bipolar 2. Thompson, cemented, unipolar	RCT (250)	100	Mortality (4 and 12 months, 250)
Cornell 1998	1. Cemented modular, bipolar 2. Cemented modular, unipolar	RCT (48)	100	Function (6 months, 48) Mobility (6 months, 48) Mortality (6 months, 48)
Davison 2001	1. Cemented, Monk, bipolar 2. Cemented, Thompson, unipolar	RCT (187)	100	Mortality (12 and 36 months, 187) Unplanned return to theatre (36 months, 187)
Figved 2018	1. Cemented, 28 mm cobalt chromium head and a SelfCentering Bipolar (DePuy) 2. Cemented, Modular Cathcart Unipolar (DePuy)	RCT (28)	100	Function (48 months, 19) HRQoL (12 months, 25; 48 months, 19) Mortality (3 and 12 months, 28)
Hedbeck 2011	1. Cemented, UHR (Stryker), from 42 to 72 mm, bipolar 2. Cemented, Exeter modular, unipolar	RCT (120)	100	ADL (12 months, 99) HRQoL (4 months, 115; 12 months, 99) Mortality (4 and 12 months, 120) Unplanned return to theatre (12 months, 120)
Jeffcote 2010	1. Cemented, Centrax, bipolar 2. Cemented, Unitrax, unipolar	RCT (51)	100	Mortality (24 months, 51)
Kanto 2014	1. Cemented, Vario cup, bipolar 2. Cemented, Lubinus, unipolar	RCT (175)	100	Mortality (during hospital stay and 5 years, 175) Unplanned return to theatre (5 years, 175)
Malhotra 1995	1. Uncemented, Bateman type, bipolar 2. Uncemented; Austin-Moore; unipolar	RCT (68)	NR	Function (NR, 66)

Table 4. Implant and study characteristics. Bipolar HA versus unipolar HA *(Continued)*

Patel 2008	1. Uncemented, medical internation stem, bipolar 2: Uncemented, Thompson; unipolar	RCT (40)	100	Mortality (13 months, 40)
Raia 2003	1. Centrax, appropriate-sized cemented Premise stem, bipolar 2. Unitrax; appropriate-sized cemented Premise stem, unipolar	RCT (115)	100	Mortality (12 months, 115)
Stoffel 2013	1. Cemented, collarless polished stem, bipolar 2. Cemented, collarless polished stem, unipolar	RCT (294)	100	Delirium (12 months, 261) Function (12 months, 251) Mobility (12 months, 186)

ADL: activities of daily living
HA: hemiarthroplasty
HRQoL: health-related quality life
N: total number randomised
n: number analysed
NR: not reported
RCT: randomised controlled trial
UHR: universal head system (manufacturer's name)

Table 5. Implant and study characteristics. HAs versus other HAs

Study ID	Type of HA in each intervention group	Study design (N)	Displaced fractures, %	Critical review outcomes (time point, n)
Lim 2020	1. Short stem, Bencox M stem, proximal Ti-plasma spray microporous coating, uncemented, bipolar 2. Standard stem, Bencox ID stem, proximal Ti-plasma spray microporous coating, uncemented, standard stem, bipolar	RCT (151)	100	ADL (24 months, 75) Mortality (24 months, 151)
Livesley 1993	1. HAC bipolar 2. Uncemented; press-fit Moore-bipolar	Quasi-RCT (82)	100	Mortality (1 and 12 months, 82) Unplanned return to theatre (12 months, 82)
Parker 2012	1. Uncemented, Exeter, unipolar 2. Cemented, Thompson, unipolar	RCT (200)	100	Delirium (12 months, 200) Mortality (3 and 12 months, 200) Unplanned return to theatre (12 months, 200)
Sims 2018	1. Uncemented, Exeter, unipolar 2. Cemented, Thompson, unipolar	RCT (964)	100	HRQoL (4 months, 618) Mobility (4 months, 494) Mortality (4 months, 964)

Table 5. Implant and study characteristics. HAs versus other HAs *(Continued)*

				Unplanned return to theatre (12 months, 964)

ADL: activities of daily living
HA: hemiarthroplasty
HAC: hydroxyapatite-coated
HRQoL: health-related quality of life
N: total number randomised
n: number analysed
RCT: randomised controlled trial

Table 6. Implant and study characteristics. THA versus HA

Study ID	Type of THA Type of HA	Study design (N)	Displaced fractures, %	Critical review outcomes (time point, n)
Baker 2006	1. 28 mm femoral head articulating with an all-polyethylene Zimmer cemented acetabular cup 2. Endo Femoral Head (Zimmer); cemented; unipolar	RCT (81)	100	Mortality (39 months, 81)
Blomfeldt 2007	1. Modular Exeter femoral component; 28 mm head; OGEE cemented acetabular component 2. Bipolar; modular Exeter, 28 mm head	RCT (120)	100	ADL (4 months, 114; 12 months, 111) Delirium (4 months, 116) Function (48 months, 83) Mortality (4, 12 and 48 months, 120)
Cadossi 2013	1. Uncemented Conus stem and a large-diameter femoral head 2. Uncemented, bipolar	RCT (96)	100	Mortality (12 and 36 months, 96)
Chammout 2019	1. Cemented 32 mm cobalt-chromium head; cemented highly cross-linked polyethylene acetabular component 2. Cemented, unipolar	RCT (120)	100	ADL (3 months, 111; 24 months, 99) Delirium (3 months, 111) Function (24 months, 103) HRQoL (3 months, 111; 12 months, 106) Mortality (24 months, 120) Unplanned return to theatre (24 months, 120)
Dorr 1986	1. 28 mm head size was used 2. Cemented (n = 37) or uncemented (n = 13), bipolar	RCT (89)	100	Unplanned return to theatre (48 months, 89)
HEALTH 2019	1. Surgeon's preference 2. Surgeon's preference	RCT (1495)	100	Function (24 months, 669) HRQoL (24 months, 844)

Table 6. Implant and study characteristics. THA versus HA *(Continued)*

				Mobility (24 months, 535) Mortality (24 months, 1441) Unplanned return to theatre (24 months, 1441)
Iorio 2019	1. Dual mobility cup with cementless femoral stem 2. Cementless femoral stem with bipolar head	RCT (60)	100	Mortality (1 and 12 months, 60) Unplanned return to theatre (12 months, 60)
Keating 2006	1. NR 2. Bipolar, cemented	RCT (180)	100	Delirium (24 months, 168) Function (24 months, 168) HRQoL (4 and 12 months, 168) Mortality (24 months, 180) Unplanned return to theatre (12 months, 180)
Macaulay 2008	1. Surgeon's preference 2. Surgeon's preference	RCT (41)	100	Function (24 months, 40) HRQoL (12 months, 40) Mobility (12 and 24 months, 40) Mortality (24 months, 40)
Mouzopoulos 2008	1. Plus (DePuy) 2. Merete	RCT (86)	100	ADL (48 months, 43) Function (48 months, 43) Mortality (12 and 48 months, 86) Unplanned return to theatre (48 months, 49)
Parker 2019	1. CPCS stem (n=29), CPT Zimmer (n=23) 2. Monoblock Exeter Trauma Stem (n=22), CPT bipolar (n=4), CPT modular (n=27)	RCT (105)	100	ADL (12 months, 78) Delirium (12 months, 105) Mobility (12 months, 78) Mortality (4 and 12 months, 105) Unplanned return to theatre (12 months, 105)
Ravikumar 2000	1. Cemented with Howse II 2. Uncemented Austin-Moore	RCT (180)	100	Mobility (13 years, 32) Mortality (4 and 12 months and 13 years, 180) Unplanned return to theatre (12 months, 180)
Ren 2017	1. Surgeon's preference 2. Cemented	RCT (100)	NR	Function (NR, 100)

Table 6. Implant and study characteristics. THA versus HA *(Continued)*

Sharma 2016	1. NR 2. NR	RCT (80)	100	Mortality (1 week, 80)
Sonaje 2017	1. NR 2. NR	Quasi-RCT (42)	100	Function (24 months, 40)
Van den-Bekerom 2010	1. Cemented; 32 mm diameter modular head 2. Cemented, bipolar	RCT (281)	100	Mortality (12 and 60 months, 252) Unplanned return to theatre (60 months, 252)
Xu 2017	1. Uncemented prosthesis 2. Bipolar; uncemented	RCT (76)	NR	Function (60 months, 76) Mortality (60 months, 76)

ADL: activity of daily living
CPCS: collarless, polished, cemented stem
CPT: collarless, polished, double-taper design concept
HA: hemiarthroplasty
N: total number randomised
n: number analysed
NR: not reported
OGEE: manufacturer's name for implant
RCT: randomised controlled trial
THA: total hemiarthroplasty

Table 7. Implant and study characteristics. THAs versus other THAs

Study ID	Type of THA	Study design (N)	Displaced fractures %	Critical review outcomes (time point, n)
Griffin 2016	1. Single articulation: surgeon's preference 2. Dual mobility: surgeon's preference for prosthesis, Novae DM acetabular component; uncemented	RCT (21)	100	Function (12 months, 19) HRQoL (12 months, 19) Mortality (12 months, 21)
Rashed 2020	1. Single articulation: cemented 32 mm head 2. Dual mobility: cemented dual-mobility cup (Ecofit 2M)	RCT (108)	100	Function (12 months, 60) Mortality (12 months, 62)
Kim 2012	1. Short stem: short, anatomical metaphyseal-fitting cementless femoral component, 36 mm modular head, cementless acetabular component 2. Standard stem: anatomical medullary locking fully porous coated cementless femoral component, 36 mm Biolox delta ceramic modular head	RCT (161)	100	Function (24 months, 140) Mobility (24 months, 142) Mortality (12 months, 162)

DM: dual-mobility

HRQoL: health-related quality of life
N: total number randomised
n: number analysed
RCT: randomised controlled trial
THA: total hip arthroplasty

Table 8. THA (cemented vs uncemented): effects of other important outcomes and adverse events

	Number of studies	Studies	Participants	Effect estimate
Other important outcomes				
Pain at ≤ 4 months Using Pain Numerical Rating Score (range of scores from 0 to 11; lower scores indicate less pain)	1	Chammout 2017	64	MD -0.90, 95% CI -1.82 to 0.02 (favours cemented); Analysis 1.6
Pain at 12 months Using Pain Numerical Rating Score (range of scores from 0 to 11; lower scores indicate less pain)	1	Chammout 2017	63	MD 1.00, 95% CI 0.03 to 1.97 (favours uncemented); Analysis 1.6
Adverse events related to implant or fracture, or both				
Intraoperative periprosthetic fracture	1	Chammout 2017	69	RR 0.14, 95% CI 0.01 to 2.59 (favours cemented); Analysis 1.7
Postoperative periprosthetic fracture	1	Chammout 2017	69	RR 0.97, 95% CI 0.06 to 14.91 (favours cemented); Analysis 1.7
Loosening	1	Chammout 2017	69	RR 0.32, 95% CI 0.01 to 7.69 (favours cemented); Analysis 1.7
Superficial infection	1	Chammout 2017	69	RR 0.32, 95% CI 0.01 to 7.69 (favours cemented); Analysis 1.7
Dislocation	1	Chammout 2017	69	RR 0.32, 95% CI 0.04 to 2.96 (favours cemented); Analysis 1.7

CI: confidence interval
MD: mean difference
RR: risk ratio

Table 9. HA (cemented vs uncemented): effects of other important outcomes and adverse events

Outcome	Number of studies	Studies	Participants	Effect estimate
Other important outcomes				

Table 9. HA (cemented vs uncemented): effects of other important outcomes and adverse events *(Continued)*

Pain[a] Experiencing no pain at ≤ 4 months (We inverted data in 2 studies in which data were reported as complaining of pain or experiencing mid-thigh pain)	4	Harper 1994; Figved 2009; Moerman 2017; Sonne-Holm 1982	500	RR 1.11, 95% CI 1.00 to 1.22 (favours uncemented); Analysis 2.29
Pain at ≤ 4 months Using VAS, and a 9-point pain scale (lower values indicate less pain)	3	Movrin 2020; Parker 2010c; Parker 2020	802	Data not combined because of substantial statistical heterogeneity I^2 = 91%; Analysis 2.30
Pain[a] Experiencing no pain at 12 months (We inverted data in 1 study in which data were reported as complaining of pain or experiencing mid-thigh pain)	4	Emery 1991; Figved 2009; Moerman 2017; Sonne-Holm 1982	376	RR 1.17, 95% CI 0.85 to 1.63 (favours uncemented); I^2 = 77%; Analysis 2.31
Pain at 12 months Using VAS, and a 9-point pain scale (lower values indicate less pain)	4	Figved 2009; Movrin 2020; Parker 2010c; Parker 2020	726	SMD -0.06, 95% CI -0.33 to 0.21 (favours cemented); I^2 = 66%; Analysis 2.32
Pain at 12 months Mean reduction values (lower values indicate less pain)	1	Rehman 2014	110	MD -0.27, 95% CI -0.48 to -0.06 (favours cemented); Analysis 2.33
Pain at > 24 months. Reported by study authors at 5 years Using VAS (lower values indicate less pain)	1	Parker 2010c	58	MD -0.30, 95% CI -0.92 to 0.32 (favours cemented); Analysis 2.34
Pain Experiencing no pain at 5 years	1	Figved 2009	80	RR 1.00, 95% CI 0.77 to 1.30; Analysis 2.35
Length of hospital stay	9	Emery 1991; Figved 2009; Harper 1994; Moerman 2017; Parker 2010c; Parker 2020; Santini 2005; Taylor 2012; Vidovic 2013	1801	MD -0.40 days, 95% CI -1.03 to 0.23 (favours cemented); Analysis 2.36

Table 9. HA (cemented vs uncemented): effects of other important outcomes and adverse events *(Continued)*

Discharge destination Living in own home[a]	6	DeAngelis 2012; Figved 2009; Parker 2010c; Santini 2005; Taylor 2012; Fernandez 2022	2331	RR 1.05, 95% CI 0.98 to 1.13 (favours uncemented); Analysis 2.37
Adverse events related to surgery				
Intraoperative periprosthetic fracture	7	DeAngelis 2012; Figved 2009; Moerman 2017; Movrin 2020; Parker 2010c; Parker 2020; Taylor 2012	1669	RR 0.20, 95% CI 0.08 to 0.46 (favours cemented); Analysis 2.38
Postoperative periprosthetic fracture	6	Figved 2009; Moerman 2017; Movrin 2020; Santini 2005; Taylor 2012; Fernandez 2022	2819	RR 0.29, 95% CI 0.14 to 0.57 (favours cemented); Analysis 2.38
Loosening	4	Brandfoot 2000; Figved 2009; Moerman 2017; Sadr 1977	537	RR 0.52, 95% CI 0.14 to 1.89 (favours cemented); I^2 = 45%; Analysis 2.38
Deep infection	7	Figved 2009; Harper 1994; Moerman 2017; Movrin 2020; Parker 2010c; Santini 2005; Taylor 2012	1382	RR 1.56, 95% CI 0.72 to 3.38 (favours uncemented); Analysis 2.38
Superficial infection	7	DeAngelis 2012; Emery 1991; Figved 2009; Harper 1994; Moerman 2017; Parker 2010c; Parker 2020; Sonne-Holm 1982; Taylor 2012; Fernandez 2022	1210	RR 1.23, 95% CI 0.73 to 2.06 (favours uncemented); Analysis 2.38
Dislocation	8	Figved 2009; Harper 1994; Moerman 2017; Movrin 2020; Parker 2010c; Parker 2020; Sadr 1977; Santini 2005; Taylor 2012; Fernandez 2022	3032	RR 1.08, 95% CI 0.61 to 1.91 (favours uncemented); Analysis 2.38
Adverse events unrelated to surgery				
Acute kidney injury	4	Moerman 2017; Parker 2010c; Parker 2020; Fernandez 2022	2226	RR 1.23, 95% CI 0.76 to 2.00 (favours uncemented); Analysis 2.39
Blood transfusion	7	DeAngelis 2012; Figved 2009; Moerman 2017; Parker 2010c; Parker 2020; Talsnes 2013; Fernandez 2022	2907	RR 1.00, 95% CI 0.83 to 1.20 (favours cemented); I^2 = 36%; Analysis 2.39
Cerebrovascular accident	5	DeAngelis 2012; Moerman 2017; Parker 2010c; Parker 2020; Fernandez 2022	2356	RR 0.93, 95% CI 0.41 to 2.10 (favours cemented); Analysis 2.39
Chest infection/pneumonia	8	DeAngelis 2012; Emery 1991; Figved 2009; Moerman 2017; Parker 2010c; Parker 2020; Taylor 2012; Fernandez 2022	2789	RR 0.78, 95% CI 0.50 to 1.21 (favours cemented); Analysis 2.39
Myocardial infarction	7	DeAngelis 2012; Figved 2009; Moerman 2017; Parker 2010c; Parker 2020; Santini 2005; Fernandez 2022	1457	RR 0.91, 95% CI 0.44 to 1.89 (favours cemented); Analysis 2.39

Table 9. HA (cemented vs uncemented): effects of other important outcomes and adverse events *(Continued)*

Urinary tract infection	5	Emery 1991; Moerman 2017; Santini 2005; Taylor 2012; Fernandez 2022	1745	RR 0.89, 95% CI 0.65 to 1.20 (favours cemented); Analysis 2.39
Venous thromboembolic phenomena (DVT)	7	Cao 2017; DeAngelis 2012; Figved 2009; Moerman 2017; Parker 2010c; Parker 2020; Fernandez 2022	2661	RR 1.28, 95% CI 0.56 to 2.90 (favours uncemented); Analysis 2.39
Venous thromboembolic phenomena (pulmonary embolism)	6	Emery 1991; Figved 2009; Moerman 2017; Parker 2010c; Parker 2020; Fernandez 2022	2499	RR 3.56, 95% CI 1.26 to 10.11 (favours uncemented); Analysis 2.39

[a]Other data is reported in Appendix 5
CI: confidence interval
DVT: deep vein thrombosis
MD: mean difference
RR: risk ratio
VAS: visual analogue scale

Table 10. THA (mixed HA and THA): cemented vs uncemented: effects of other important outcomes and adverse events

Outcome	Number of studies	Studies	Participants	Effect estimate
Adverse events related to the implant or fracture, or both				
Intraoperative periprosthetic fracture	1	Inngul 2015	141	RR 0.06, 95% CI 0.00 to 0.98 (favours cemented); Analysis 3.9
Superficial infection	1	Inngul 2015	141	RR 0.49, 95% CI 0.16 to 1.52 (favours cemented); Analysis 3.9
Dislocation	1	Moroni 2002	28	RR 0.87, 95% CI 0.14 to 5.32 (favours cemented); Analysis 3.9
Adverse events unrelated to implant or fracture, or both				
Acute kidney injury	1	Inngul 2015	141	RR 0.37, 95% CI 0.02 to 8.87 (favours cemented); Analysis 3.10
Chest infection/pneumonia	1	Inngul 2015	141	RR 0.55, 95% CI 0.05 to 5.95 (favours cemented); Analysis 3.10
Myocardial infarction	1	Inngul 2015	141	RR 0.37, 95% CI 0.02 to 8.87 (favours cemented); Analysis 3.10
Urinary tract infection	1	Inngul 2015	141	RR 1.42, 95% CI 0.56 to 3.60 (favours uncemented); Analysis 3.10

CI: confidence interval
RR: risk ratio

Table 11. HA (bipolar vs unipolar): effects of other important outcomes and adverse events

Outcome	Number of studies	Studies	Participants	Effect estimate
Other important outcomes				
Pain (categorical data; no pain, or mild pain)	2	Abdelkhalek 2011; Calder 1996	300	RR 1.22, 95% CI 0.82 to 1.82; I^2 = 61% (favours bipolar); Analysis 4.14
Pain[a] Using Numerical Rating Scale (lower scores indicate less pain)	1	Stoffel 2013	233	MD -0.60, 95% CI -1.07 to -0.13 (favours bipolar); Analysis 4.15
Length of hospital stay[a]	1	Stoffel 2013	261	MD 0.20 days, 95% CI -0.95 to 1.35 (favours unipolar); Analysis 4.16
Discharge destination	2	Calder 1996; Kanto 2014	381	RR 0.95, 95% CI 0.84 to 1.08 (favours bipolar); Analysis 4.17
Adverse events related to surgery				
Periprosthetic fracture	1	Hedbeck 2011	120	RR 7.00, 95% CI 0.37 to 132.66 (favours unipolar); Analysis 4.18
Deep infection	7	Calder 1996; Davison 2001; Hedbeck 2011; Jeffcote 2010; Kanto 2014; Malhotra 1995; Stoffel 2013	1122	RR 1.10, 95% CI 0.44 to 2.71 (favours unipolar); Analysis 4.18
Superficial infection	1	Stoffel 2013	261	RR 2.41, 95% CI 0.48 to 12.18 (favours unipolar); Analysis 4.18
Dislocation	9	Abdelkhalek 2011; Calder 1996; Cornell 1998; Davison 2001; Hedbeck 2011; Kanto 2014; Malhotra 1995; Raia 2003; Stoffel 2013	1274	RR 0.62, 95% CI 0.28 to 1.38 (favours bipolar); Analysis 4.18
Adverse events unrelated to surgery				
Acute kidney injury	1	Stoffel 2013	261	RR 2.89, 95% CI 0.12 to 70.25 (favours unipolar); Analysis 4.19
Blood transfusion	1	Raia 2003	115	RR 0.91, 95% CI 0.51 to 1.62 (favours bipolar); Analysis 4.19
Cerebrovascular accident	2	Kanto 2014; Stoffel 2013	436	RR 1.57, 95% CI 0.20 to 12.69 (favours unipolar); Analysis 4.19
Chest infection/pneumonia	3	Hedbeck 2011; Kanto 2014; Stoffel 2013	556	RR 0.61, 95% CI 0.10 to 3.86 (favours bipolar); Analysis 4.19

Table 11. HA (bipolar vs unipolar): effects of other important outcomes and adverse events *(Continued)*

Myocardial infarction	3	Hedbeck 2011; Kanto 2014; Stoffel 2013	556	RR 0.69, 95% CI 0.11 to 4.32 (favours bipolar); Analysis 4.19
Urinary tract infection	1	Stoffel 2013	261	RR 0.96, 95% CI 0.29 to 3.25 (favours bipolar); Analysis 4.19
Venous thromboembolic phenomena (DVT)	2	Hedbeck 2011; Stoffel 2013	381	RR 3.84, 95% CI 0.43 to 34.45 (favours unipolar); Analysis 4.19
Venous thromboembolic phenomena (pulmonary embolism)	1	Hedbeck 2011	120	RR 3.00, 95% CI 0.12 to 72.20 (favours bipolar); Analysis 4.19

[a]Additional data are reported in Appendix 4. We did not calculate effect estimates for the data in Appendix 4 because study authors did not report distribution variables that we required for analysis.

CI: confidence interval
DVT: deep vein thrombosis
MD: mean difference
RR: risk ratio

Table 12. HA (short stem vs standard stem): effects of other important outcomes and adverse events

Outcome	Number of studies	Studies	Participants	Effect estimate
Other important outcomes				
Pain (experiencing thigh pain; at 2 years)	1	Lim 2020	71	RR 0.87, 95% CI 0.13 to 5.83 (favours short stem) Analysis 5.3
Adverse events related to the implant or fracture, or both				
Postoperative periprosthetic fracture	1	Lim 2020	151	RR 0.96, 95% CI 0.14 to 6.65 (favours short stem); Analysis 5.3
Loosening	1	Lim 2020	151	Not estimable. No events in either group
Superficial infection	1	Lim 2020	151	Not estimable. No events in either group
Dislocation	1	Lim 2020	112	RR 0.93, 95% CI 0.06 to 14.52 (favours short stem); Analysis 5.3

CI: confidence interval
RR: risk ratio

Table 13. HA: ETS vs Thompson: effects of adverse events

Outcome	Number of studies	Studies	Participants	Effect estimate

Table 13. HA: ETS vs Thompson: effects of adverse events *(Continued)*

Adverse events related to the implant or fracture, or both				
Intraoperative periprosthetic fracture	1	Parker 2012	200	RR 1.00, 95% CI 0.21 to 4.84 (favours neither); Analysis 6.7
Deep infection	1	Parker 2012	200	Not estimable; zero events in both groups
Superficial infection	1	Parker 2012	200	RR 3.00, 95% CI 0.32 to 28.35 (favours Thompson); Analysis 6.7
Dislocation	1	Parker 2012	200	RR 0.20, 95% CI 0.01 to 4.11 (favours ETS); Analysis 6.7
Adverse events unrelated to implant or fracture, or both				
Acute kidney injury	1	Parker 2012	200	RR 1.00, 95% CI 0.06 to 15.77 (favours neither); Analysis 6.8
Blood transfusion	1	Parker 2012	200	RR 1.00, 95% CI 0.54 to 1.84 (favours neither); Analysis 6.8
Cerebrovascular accident	1	Parker 2012	200	RR 2.00, 95% CI 0.18 to 21.71 (favours Thompson); Analysis 6.8
Chest infection/pneumonia	1	Parker 2012	200	RR 1.67, 95% CI 0.41 to 6.79 (favours Thompson); Analysis 6.8
Myocardial infarction	1	Parker 2012	200	RR 5.00, 95% CI 0.24 to 102.85 (favours Thompson); Analysis 6.8
Venous thromboembolic phenomena (DVT)	1	Parker 2012	200	RR 1.00, 95% CI 0.21 to 4.84 (favours neither); Analysis 6.8
Venous thromboembolic phenomena (pulmonary embolism)	1	Parker 2012	200	Not estimable; zero events in both groups

CI: confidence interval
DVT: deep vein thrombosis
ETS: Exeter trauma stem
HA: hemiarthroplasty
RR: risk ratio

Table 14. HA: Furlong vs Austin-Moore: effects of other important outcomes and adverse events

Outcome	Number of studies	Studies	Participants	Effect estimate
Other important outcomes				
Pain at rest (at 12 months)	1	Livesley 1993	82	RR 0.71, 95% CI 0.22 to 2.26 (favours Furlong); Analysis 7.4
Adverse events related to surgery				

Table 14. HA: Furlong vs Austin-Moore: effects of other important outcomes and adverse events *(Continued)*

Periprosthetic fracture	1	Livesley 1993	82	RR 10.71, 95% CI 0.63 to 181.50 (favours Moore); Analysis 7.5
Superficial infection	1	Livesley 1993	82	RR 0.71, 95% CI 0.05 10.93 (favours Furlong); Analysis 7.5
Dislocation	1	Livesley 1993	82	RR 2.14, 95% CI 0.09 to 51.07 (favours Moore); Analysis 7.5

CI: confidence interval
RR: risk ratio

Table 15. THA vs HA: effects of other important outcomes and adverse events

Outcome	Number of studies	Studies	Participants	Effect estimate
Other important outcomes				
Pain[a] (reported at ≤ 4 months) Using Hip Rating Questionnaire or HHS (higher scores indicate less pain), and VAS and 8-point pain scale (lower scores indicate less pain; data inverted in meta-analysis)	5	Blomfeldt 2007; Cadossi 2013; Chammout 2019; Keating 2006; Parker 2019	572	SMD 0.10, 95% CI -0.10 to 0.30 (favours THA); Analysis 8.27
Pain[a] (at 12 months) Using VAS, 8-point pain scale or WOMAC (lower scores indicate less pain); and Hip Rating Questionnaire, WOMAC[b] or HHS (higher scores indicate less pain; data inverted in meta-analysis) Follow-up: 12 months and 24 months	7	Blomfeldt 2007; Cadossi 2013; Chammout 2019; HEALTH 2019; Keating 2006; Macaulay 2008; Parker 2019; Sonaje 2017	1359	SMD -0.19, 95% CI -0.44 to 0.06 (favours THA); I^2 = 73%; Analysis 8.24
Pain (> 24 months) Using HHS (higher scores indicate less pain) Follow-up: 48 months	2	Blomfeldt 2007; Cadossi 2013	83	We did not combine data because of substantial statistical heterogeneity (I^2 = 96%); Analysis 8.25
Pain (> 24 months) Using categorical data; we report data for those experiencing no pain[c] Follow-up: 13 years	1	Ravikumar 2000	135	RR 1.47, 95% CI 1.07 to 2.00 (favours THA); Analysis 8.26

Table 15. THA vs HA: effects of other important outcomes and adverse events *(Continued)*

Length of hospital stay[a]	4	Keating 2006; Macaulay 2008; Mouzopoulos 2008; Xu 2017	382	MD 0.72 days, 95% CI -0.21 to 1.64 (favours HA); Analysis 8.23
Discharge destination (own home)	2	HEALTH 2019; Keating 2006	1612	RR 0.97, 95% CI 0.87 to 1.08 (favours HA); Analysis 8.28
Discharge destination (geriatric ward)	1	Chammout 2019	120	RR 0.88, 95% CI 0.34 to 2.26 (favours HA); Analysis 8.29
Adverse events related to the implant or fracture, or both				
Postoperative periprosthetic fracture	3	HEALTH 2019; Sonaje 2017; Xu 2017	1557	RR 1.08, 95% CI 0.70 to 1.66 (favours HA); Analysis 8.30
Prosthetic loosening	4	Blomfeldt 2007; HEALTH 2019; Van den Bekerom 2010; Xu 2017	1889	RR 0.64, 95% CI 0.17 to 2.41 (favours THA); Analysis 8.30
Deep infection	8	Chammout 2019; Dorr 1986; HEALTH 2019; Parker 2019; Ravikumar 2000; Sharma 2016; Xu 2017; Van den Bekerom 2010	2343	RR 0.87, 95% CI 0.50 to 1.54 (favours THA); Analysis 8.30
Superficial infection	10	Baker 2006; Blomfeldt 2007; Chammout 2019; Dorr 1986; HEALTH 2019; Keating 2006; Macaulay 2008; Parker 2019; Sharma 2016; Van den-Bekerom 2010	2495	RR 1.25, 95% CI 0.67 to 2.30 (favours HA); Analysis 8.30
Dislocation	12	Baker 2006; Blomfeldt 2007; Chammout 2019;Dorr 1986; HEALTH 2019; Iorio 2019; Keating 2006; Macaulay 2008; Ravikumar 2000; Sharma 2016; Van den Bekerom 2010; Xu 2017	2719	RR 1.96, 95% CI 1.17 to 3.27 (favours HA); Analysis 8.30
Adverse events unrelated to the implant or fracture, or both				
Acute kidney injury	2	Chammout 2019; HEALTH 2019	1561	RR 1.09, 95% CI 0.62 to 1.92 (favours HA); Analysis 8.31
Blood transfusion	2	Keating 2006; Parker 2019	285	RR 2.14, 95% CI 1.27 to 3.61 (favours HA); Analysis 8.31
Cerebrovascular accident	4	Chammout 2019; Keating 2006; Parker 2019; Van den-Bekerom 2010	657	RR 1.63, 95% CI 0.63 to 4.21 (favours HA); Analysis 8.31
Chest infection/pneumonia (reported at > 4 months)	5	Baker 2006; Blomfeldt 2007; Chammout 2019; Macaulay 2008; Van den Bekerom 2010	613	RR 0.87, 95% CI 0.38 to 2.00 (favours THA); Analysis 8.31

Table 15. THA vs HA: effects of other important outcomes and adverse events *(Continued)*

Myocardial infarction	4	Blomfeldt 2007; Chammout 2019; Keating 2006; Macaulay 2008	460	RR 1.48, 95% CI 0.48, 4.58 (favours HA); Analysis 8.31
Urinary tract infection	1	Macaulay 2008	40	RR 0.19, 95% CI 0.01 to 3.46 (favours THA); Analysis 8.31
Venous thromboembolic phenomena (DVT)	4	Baker 2006; Blomfeldt 2007; Keating 2006; Parker 2019	486	RR 4.25, 95% CI 0.86 to 21.06 (favours HA); Analysis 8.31
Venous thromboembolic phenomena (pulmonary embolism)	5	Baker 2006; Chammout 2019; Keating 2006; Macaulay 2008; Van den Bekerom 2010	673	RR 0.49, 95% CI 0.14 to 1.63 (favours THA); Analysis 8.31

[a]Additional data are reported in Appendix 8. We did not calculate effect estimates for the data in Appendix 8 because study authors did not report distribution variables that we required for analysis.

[b]Two studies reported data from different versions of the WOMAC scale, with opposite directions of effect. We inverted the data from one of these studies so that the direction was consistent across the analysis.

[c]Data for additional categories are reported in Appendix 5.

CI: confidence interval
DVT: deep vein thrombosis
HA: hemiarthroplasty
MD: mean difference
RR: risk ratio
SMD: standardised mean difference
THA: total hip arthroplasty
VAS: visual analogue scale
WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index

Table 16. THA (dual-mobility cup vs standard cup): effects of other important outcomes and adverse events

Outcome	Number of studies	Studies	Participants	Effect estimate
Adverse events related to implant or fracture, or both				
Deep infection	1	Rashed 2020	62	RR 1.00, 95% CI 0.07 to 15.28 (favours neither); Analysis 9.5
Superficial infection	1	Rashed 2020	62	RR 3.00, 95% CI 0.33 to 27.29 (favours DM); Analysis 9.5
Dislocation	2	Griffin 2016; Rashed 2020	82	Not estimable; zero events in both groups
Adverse events unrelated to implant or fracture, or both				
Venous thromboembolic phenomena	1	Rashed 2020	62	RR 0.33, 95% CI 0.01 to 7.88 (favours single); Analysis 9.6

CI: confidence interval
DM: dual-mobility
RR: risk ratio

Table 17. THA (short stem vs standard stem): effects of other important outcomes and adverse events

Outcome	Number of studies	Studies	Participants	Effect estimate
Other important outcomes				
Pain Number of people experiencing thigh pain at 24 months	1	Kim 2012	140	RR 0.04, 95% CI 0.00 to 0.72 (favours short stem); Analysis 10.4
Adverse events related to implant or fracture, or both				
Intraoperative periprosthetic fracture	1	Kim 2012	140	RR 0.13, 95% CI 0.02 to 0.97 (favours short stem); Analysis 10.5
Superficial infection	1	Kim 2012	140	RR 1.00, 95% CI 0.06 to 15.67 (favours neither); Analysis 10.5
Dislocation	1	Kim 2012	140	RR 0.25, 95% CI 0.03 to 2.18 (favours short stem); Analysis 10.5
Adverse events unrelated to implant or fracture, or both				
Acute kidney injury	1	Kim 2012	140	RR 0.50, 95% CI 0.05 to 5.39 (favours short stem); Analysis 10.6
Chest infection/pneumonia	1	Kim 2012	140	RR 0.67, 95% CI 0.11 to 3.87 (favours short stem); Analysis 10.6
Urinary tract infection	1	Kim 2012	140	RR 0.47, 95% CI 0.20 to 1.07 (favours short stem); Analysis 10.6

CI: confidence interval
RR: risk ratio

APPENDICES

Appendix 1. Search strategies

CENTRAL (CRS-Web)

#1 MESH DESCRIPTOR Femoral Fractures EXPLODE ALL AND CENTRAL:TARGET
#2 ((hip or hips or cervical) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#3 ((femoral* or femur* or acetabul*) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or trans-cervical or basicervical or basi-cervical) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#5 ((extracapsular or extra-capsular or trochant* or subtrochant* or pertrochant* or intertrochant*) NEAR5 (fracture* or break* or broke*)) AND CENTRAL:TARGET
#6 ((head or neck or proximal) NEAR5 (fracture* or break* or broke*)) and (femoral* or femur*) AND CENTRAL:TARGET
#7 #1 OR #2 OR #3 OR #4 OR #5 OR #6 AND CENTRAL:TARGET
#8 MESH DESCRIPTOR Arthroplasty, Replacement, Hip AND CENTRAL:TARGET

#9 MESH DESCRIPTOR Hip Prosthesis AND CENTRAL:TARGET
#10 MESH DESCRIPTOR Arthroplasty, Replacement AND CENTRAL:TARGET
#11 MESH DESCRIPTOR Hemiarthroplasty AND CENTRAL:TARGET
#12 MESH DESCRIPTOR Joint Prosthesis AND CENTRAL:TARGET
#13 ((arthroplast* or hemiarthroplast*) NEAR5 (hip or hips or femur* or femoral* or acetabul*)) AND CENTRAL:TARGET
#14 ((hip or hips) NEAR5 (replac* or prosthes* or implant*)) AND CENTRAL:TARGET
#15 ((joint* NEAR5 (replac* or prosthes* or implant*)) and (hip or hips or femur* or femoral* or acetabul*)) AND CENTRAL:TARGET
#16 #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 AND CENTRAL:TARGET
#17 MESH DESCRIPTOR Fractures, Bone AND CENTRAL:TARGET
#18 MESH DESCRIPTOR Fracture Dislocation EXPLODE ALL AND CENTRAL:TARGET
#19 MESH DESCRIPTOR Fractures, Closed AND CENTRAL:TARGET
#20 MESH DESCRIPTOR Fractures, Comminuted AND CENTRAL:TARGET
#21 MESH DESCRIPTOR Fractures, Compression AND CENTRAL:TARGET
#22 MESH DESCRIPTOR Fractures, Malunited AND CENTRAL:TARGET
#23 MESH DESCRIPTOR Fractures, Multiple AND CENTRAL:TARGET
#24 MESH DESCRIPTOR Fractures, Open AND CENTRAL:TARGET
#25 MESH DESCRIPTOR Fractures, Spontaneous AND CENTRAL:TARGET
#26 MESH DESCRIPTOR Fractures, Stress AND CENTRAL:TARGET
#27 MESH DESCRIPTOR Fractures, Ununited AND CENTRAL:TARGET
#28 MESH DESCRIPTOR Intra-Articular Fractures AND CENTRAL:TARGET
#29 MESH DESCRIPTOR Osteoporotic Fractures AND CENTRAL:TARGET
#30 MESH DESCRIPTOR Periprosthetic Fractures AND CENTRAL:TARGET
#31 fracture* AND CENTRAL:TARGET
#32 #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 AND CENTRAL:TARGET
#33 #32 AND #16 AND CENTRAL:TARGET
#34 (pin or pins or nail or nails or screw or screws or plate or plates) AND CENTRAL:TARGET
#35 MESH DESCRIPTOR Internal Fixators AND CENTRAL:TARGET
#36 MESH DESCRIPTOR Bone Nails AND CENTRAL:TARGET
#37 MESH DESCRIPTOR Bone Plates AND CENTRAL:TARGET
#38 MESH DESCRIPTOR Bone Screws EXPLODE ALL AND CENTRAL:TARGET
#39 (static NEXT (device* or implant*)) AND CENTRAL:TARGET
#40 (dynamic NEXT (device* or implant*)) AND CENTRAL:TARGET
#41 #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 AND CENTRAL:TARGET
#42 ((hip or hips or femur* or femoral* or acetabul*) and (fracture* or break* or broke*)) AND CENTRAL:TARGET
#43 (hip or hips or femur* or femoral* or acetabul*) AND CENTRAL:TARGET
#44 #43 AND (#17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30) AND CENTRAL:TARGET
#45 #42 OR #44 AND CENTRAL:TARGET
#46 #41 AND #45 AND CENTRAL:TARGET
#47 #7 OR #33 OR #46 AND CENTRAL:TARGET
#48 14/11/2018_TO_08/07/2020:CRSCREATED AND CENTRAL:TARGET
#49 #47 AND #48

MEDLINE (Ovid)

1 exp Femoral Fractures/
2 ((hip or hips or cervical) adj5 (fracture$ or break$ or broke$)).ti,ab,kf.
3 ((femoral$ or femur$ or acetabul$) adj5 (fracture$ or break$ or broke$)).ti,ab,kf.
4 ((intracapsular or intra-capsular or subcapital or sub-capital or transcervical or transcervical or basicervical or basi-cervical) adj5 (fracture $ or break$ or broke$)).ti,ab,kf.
5 ((extracapsular or extra-capsular or trochant$ or subtrochant$ or pertrochant$ or intertrochant$) adj5 (fracture$ or break$ or broke $)).ti,ab,kf.
6 (((head or neck or proximal) adj5 (fracture$ or break$ or broke$)) and (femoral$ or femur$)).ti,ab,kf.
7 or/1-6
8 randomized controlled trial.pt.
9 controlled clinical trial.pt.
10 randomized.ab.
11 placebo.ab.
12 clinical trials as topic.sh.
13 randomly.ab.
14 trial.ti.
15 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:

(Continued)

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:

- 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:

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	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 anti-thromboembolics), 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 specified*
Outcomes	Outcomes measured/reported by study authors: Outcomes relevant to the review: *include measurement tools and time point of measure used in review analysis* **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:**

Appendix 3. Scales used in 'critical outcomes'

Outcome	Scale	Range	Direction of effect
ADL	Katz ADL (Katz 1963)	0 to 6	6 indicating full function; 2 or less indicates severe functional impairment
	Katz ADL (Katz 1963)	A to G	A: independence in all six functions B: independence in all but one of the six functions. C–G: dependence in bathing and at least one more function.
	Groningen Activity Restriction Scale (Suurmeijer 1994)	18 to 72	Lower scores indicate greater independence
	OARS-IADL (Fillenbaum 1981)	0 to 14	Higher scores indicate greater independence

(Continued)

	Parker social dependency (Parker 2020)	1 to 8	Lower scores indicate greater independence
	Barthel Index - ADL (Mahoney 1965)	0 to 20	Higher scores indicate greater independence
	Barthel Index – ADL (Wade 1988)	0 to 100	Higher scores indicate greater independence
	VELCA (Spolaore 2001)	1 to 18	Higher scores indicate greater independence
	WOMAC (Roos 1999)	0 to 96	Lower scores indicate better function
Functional status	HHS (Singh 2016)	0 to 100	Higher scores indicate better function
	D'Aubigne (D'Aubigne 1954)	0 to 6	Higher scores indicate better function
	Hip Rating Questionnaire (Johanson 1992)	0 to 100	Higher score indicates better function
	Devas and Hinves (Devas 1983)	Categorical	Good, medium, poor
	Assessment of Hip and Knee surgery (Benjamin 1990)	0 to 5; over 9 domains; overall score up to 45	Higher score indicates better function
	Oxford Hip Score (Dawson 1996)	0 to 48	Higher score indicates better function
HRQoL	EQ-5D (EuroQol 1990)	-0.654 (worst quality of life) 0 (dead) 1 (best quality of life)	Higher scores indicate better quality of life
	SF-12 (Mols 2009)	0 to 100	Higher scores indicate better quality of life
	SF-36 (SF-36)	0 to 100	Higher scores indicate better quality of life
Mobility	Parker scale (Parker 1993b)	0 to 9	Higher scores indicate better mobility
	Timed Up and Go (TUG) (Podsiadlo 1991)	To stand from a seated position and walk 6 steps	Lower time indicates better mobility
	6 minute walk test (Overgaard 2017)	Distance walked in 6 mins	Higher distance indicates better mobility
	Parker scale (Parker 2019)	1 to 9	Lower scores indicate better mobility

(Continued)

Nottingham Health Profile: mobility sub-scale (Wiklund 1990)	0 to 100	Lower scores indicate better mobility
VELCA - walking (Spolaore 2001)	0 to 6	Higher scores indicate better mobility
Koval (Koval 1995)	Level I to VII	Dichotomised to either ambulatory indoors or outdoors; lower scores indicate greater independent mobility

Footnotes:

ADL: activities of daily living; **EQ-5D:** EuroQoL 5 Dimensions instrument; **HHS:** Harris Hip Score; **OARS-IADL:** Older Americans Resources Scale of Instrumental Activities of Daily Living; **SF-36 or SF-12:** short-form 36 or short-form 12; **WOMAC:** Western Ontario and McMAster Osteoarthritis index; **VELCA:** Verona Elderly Care

Appendix 4. Prostheses implanted with cement versus without cement: data incomplete and not included in analysis

	Measurement tool	Interventions	Study ID	Data for Intervention 1	Data for Intervention 2	Additional information P value reported by study authors
HA: cemented versus uncemented						
ADL **(12 months)**	Modified HHS activities domain Follow-up: 16 months	1. Cemented; unipolar (Thompson) 2. Uncemented; unipolar (Thompson)	Brandfoot 2000	Mean: 1.64 n = 31	Mean: 1.61 n = 39	No SD No P value
Functional status **(12 months)**	HHS total Follow-up: 16 months	1. Cemented; unipolar (Thompson) 2. Uncemented; unipolar (Thompson)	Brandfoot 2000	Mean: 6.15 n = 31	Mean: 5.97 n = 39	No SD No P value
Mobility **(12 months)**	HHS mobility domain Follow-up: 16 months	1. Cemented; unipolar (Thompson) 2. Uncemented; unipolar (Thompson)	Brandfoot 2000	Mean: 1.38 n = 31	Mean: 1.37 n = 39	No SD No P value
	TUG Follow-up: 24 months	1. Cemented 2. Uncemented	Taylor 2012	Mean: 24.7 n = 21	Mean: 26.9 n = 27	No SD No P value
Pain **(12 months)**	HHS pain domain Follow-up: 16 months	1. Cemented; unipolar (Thompson) 2. Uncemented; unipolar (Thompson)	Brandfoot 2000	Mean: 0.42 n = 31	Mean: 0.24 n = 39	No SD No P value
	VAS	1. Cemented	Taylor 2012	Mean: 2.24	Mean: 2.77	No SD

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	Follow-up: 24 months	2. Uncemented		n = 21	n = 27	No P value
Mixed HA/THA: cemented versus uncemented						
Functional status (≤ 4 months)	HHS total Follow-up: 4 months	1. Cemented; unipolar or THA 2. Uncemented; unipolar or THA	Inngul 2015	Mean (SD): 78 (± 14)	Mean (SD): 70.7 (± 14.6)	Number of participants not reported for each group P = 0.004; N = 127
Functional status (12 months)	HHS total Follow-up: 12 months	1. Cemented; unipolar or THA 2. Uncemented; unipolar or THA	Inngul 2015	Mean (SD): 82.3 (± 13.1)	Mean (SD): 78.6 (± 17.1)	Number of participants not reported for each group P = 0.93; N = 123
Pain (≤ 4 months)	HHS pain score Follow-up: 4 months	1. Cemented; unipolar or THA 2. Uncemented; unipolar or THA	Inngul 2015	Mean (SD): 39.6 (± 8.2)	Mean (SD): 37.2 (± 9.1)	Number of participants not reported for each group P = 0.065; N = 127
Pain (12 months)	HHS pain score Follow-up: 12 months	1. Cemented; unipolar or THA 2. Uncemented; unipolar or THA	Inngul 2015	Mean (SD): 40.7 (± 8.8)	Mean (SD): 38.9 (± 9)	Number of participants not reported for each group P = 0.101; N = 123

ADL: activities of daily living
HA: hemiarthroplasty
HHS: Harris hip score
OHS: Oxford hip score
n: number analysed per group
N: number randomised to both groups
SD: standard deviation
SMFA: Short Musculoskeletal Function Assessment
THA: total hip arthroplasty
TUG: Timed Up and Go
VAS: visual analogue scale

Appendix 5. HA bipolar versus unipolar: data incomplete and not included in analysis

	Measurement tool	Interventions	Study ID	Data for Intervention 1	Data for Intervention 2	Additional information P value reported by study authors
Bipolar versus unipolar						
ADL (12 months)	Musculoskeletal Functional Assessment Instrument; self care ADL	1, Bipolar 2. Unipolar	Raia 2003	Average: 37.0 n = 55	Average: 32.9 n = 60	Not specified whether mean or median; no SD or IQR P = 0.65

(Continued)

	Follow-up: 12 months					
Functional status (≤ 4 months)	HHS Follow-up: 4 months	1. Bipolar; cemented 2. Unipolar; cemented	Hedbeck 2011	Mean (range): 75.5 (24-95) n = 56	Mean (range): 73.8 (44-98) n = 59	No SD P = 0.17
Functional status (12 months)	HHS Follow-up: 12 months	1. Bipolar; cemented (Monk) 2. Unipolar; cemented (Thompson)	Davison 2001	Mean: 73.2 n = 85	Mean: 71.1 n = 80	No SD No P value
	HHS Follow-up: 12 months	1. Bipolar, uncemented 2. Unipolar, uncemented	Figved 2018	Median (IQR): 100 (95 to 100) n = 10	Median (IQR): 75 (70 to 85) n = 12	We reported median values owing to small sample size P = 0.001
	HHS Follow-up: 12 months	1. Bipolar; cemented 2. Unipolar; cemented	Hedbeck 2011	Mean (range): 77.7 (33-100) n = 46	Mean (range): 78.2 (34-100); n = 53	No SD P = 1.0
	Physical function from SF-36 Follow-up:12 months	1. Bipolar 2. Unipolar	Raia 2003	Average: 54.2 n = 55	Average: 51.6 n = 60	Not specified whether mean or median; no SD or IQR P > 0.05
Functional status (> 24 months)	HHS Follow-up: 60 months	1. Bipolar; cemented (Monk) 2. Unipolar; cemented (Thompson)	Davison 2001	Mean: 73.6 n = unknown	Mean: 71.8 n = unknown	No SD No P value
HRQoL (12 months)	EQ-5D Follow-up: 12 months	1. Bipolar, uncemented 2. Unipolar, uncemented	Figved 2018	Median (IQR): 1.0 (0.84 to 1.0) n = 12	Median (IQR): 0.68 (0.52 to 0.82) n = 12	We reported median values owing to small sample size P = 0.003
	SF-36 general health Follow-up: 12 months	1. Bipolar 2. Unipolar	Raia 2003	Average: 74.3 n = 55	Average 72.7 n = 60	Not specified whether mean or median; no SD or IQR P > 0.05
Mobility (12 months)	Nottingham Health Profile[a] physical mobility domain Follow-up: 6 months	1. Bipolar; cemented (Monk) 2. Unipolar; cemented (Thompson)	Calder 1995	Median: Male, 23.4 Female 12.7 n = 39	Median: Male, 44.3 Female 67.0 n = 34	No SD No P value

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	Nottingham Health Profile physical mobility domain Follow-up: 6 months	1. Bipolar; cemented (Monk) 2. Unipolar; cemented (Thompson)	Calder 1996	Median: Male, 46.1 Female, 66.6 n = 56	Median: Male, 46.2 Female, 61.5 n = 72	No SD No P value
	Mobility domain of Musculoskeletal Functional Assessment Instrument[b] Follow-up: 12 months	1. Bipolar 2. Unipolar	Raia 2003	Average: 46.9	Average: 47.4	Not specified whether mean or median; no SD or IQR P = 0.94
Pain (≤ 4 months)	HHS pain score Follow-up: 4 months	1. Bipolar; cemented 2. Unipolar; cemented	Hedbeck 2011	Mean (range): 40.3 (10 to 44) n = 56	Mean (range): 39.5 (20 to 44) n = 59	No SD P = 0.22
Pain (12 months)	Nottingham Health Profile pain domain Follow-up: 6 months	1. Bipolar; cemented (Monk) 2. Unipolar; cemented (Thompson)	Calder 1995	Median: Male, 10.6 Female, 0.0 n = 39	Median: Male, 5.8 Female, 26.0 n = 34	No SD No P value
	Nottingham Health Profile pain domain Follow-up: 6 months	1. Bipolar; cemented (Monk) 2. Unipolar; cemented (Thompson)	Calder 1996	Median: Male, 0.0 Female, 38.8 n = 56	Median: Male, 10.0 Female, 11.4 n = 72	No SD No P value
	HHS pain score Follow-up: 12 months	1. Bipolar; cemented 2. Unipolar; cemented	Hedbeck 2011	Mean (range): 40.5 (20 to 44) n = 46	Mean (range): 41.3 (20 t0 44) n = 53	No SD P = 0.92
	SF-36; bodily pain function Follow-up: 12 months	1. Bipolar 2. Unipolar	Raia 2003	Average: 77.8	Average: 80	Not specified whether mean or median; no SD or IQR P > 0.05
Length of stay (LOS) in hospital	LOS (days)	1. Bipolar; cemented (Monk) 2. Unipolar; cemented (Thompson)	Calder 1996	Median (IQR): 17 (13-22) n = 118	Median (IQR): 18 (13-23) n = 132	No mean or SD No P value
	LOS (days)	1. Bipolar; cemented 2. Unipolar; cemented	Cornell 1998	Mean (range): 13.4 (4 to 30) n = 33	Mean (range): 10.3 (5 to 23) n = 15	No SD No P value

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LOS (days)	1. Bipolar; cemented (Monk) 2. Unipolar; cemented (Thompson)	Davison 2001	Median (IQR): 15 (13-21) n = 97	Median (IQR): 15 (1-2) n = 90	No mean or SD No P value
LOS (days)	1. Bipolar; Bateman type; uncemented 2. Unipolar; Austin-Moore; uncemented	Malhotra 1995	Average: 17.24 n = 32	Average: 18.10 n = 36	No SD; mean/median not clarified No P value
LOS (days)	1. Bipolar 2. Unipolar	Raia 2003	Mean: 5.2 n = 55	Mean: 5.5 n = 60	No SD No P value
LOS (days)	1. Bipolar; cemented 2. Unipolar; cemented (Thompson)	Patel 2008	Average: 7 n = 20	Average: 13 n = 19	No SD No P value

[a]Nottingham Health profile; scores out of 100; lower score indicates better performance

[b]Musculoskeletal Functional Assessment Instrument; lower score indicates better function

ADL: activities of daily living
HA: hemiarthroplasty
HHS: Harris hip score
HRQoL: health-related quality of life
IQR: interquartile range
LOS: length of stay in hospital
n: number analysed
SD: standard deviation
SF-36: Short-Form 36

Appendix 6. Categorical outcome data: complete data for all categories

HA vs THA

Outcome	Study ID	Short stem: n/N	Standard stem: n/N	Effect estimate as reported by study authors
Functional status	Ren 2017; Sonaje 2017	Excellent: 33/70 Good: 29/70 Medium: 7/70 Poor: 1/70	Excellent: 40/70 Good: 27/70 Medium: 3/70 Poor: 0/70	Effect estimate not reported
Pain	Ravikumar 2000	No pain: 30/66 Occasional pain: 18/66 Occasional analgesia: 3/66	No pain: 46/69 Occasional pain: 23/69 Occasional analgesia: 0/69	Effect estimate not reported

(Continued)

		Regular analgesia: 15/66	Regular analgesia: 0/69	
HA: bipolar vs unipolar				
Functional status	Abdelkhalek 2011; Malhotra 1995	Excellent: 46/57 Good: 6/57 Fair: 4/57 Poor: 1/57	Excellent: 27/61 Good: 19/61 Fair: 9/61 Poor: 6/61	Effect estimate not reported
Pain (studies did not report outcome for all categories included in this table)	Abdelkhalek 2011; Calder 1996; Livesley 1993	No pain: 17/41 Mild pain: 10/41; No pain, or mild pain: 65/118; Pain at rest: 5/34 Pain on rising from a chair: 5/34 Activity pain: 5/34	No pain: 7/37 Mild pain: 11/37; No pain, or mild pain: 70/132; Pain at rest: 5/38 Pain on rising from a chair: 5/38 Activity pain: 2/38	Effect estimate not reported
HA: cemented vs uncemented				
Functional status (Studies did not report data for all categories included in this table)	Sadr 1977; Sonne-Holm 1982	Excellent: 1/11 Good: 6/11 Fair: 3/11 Poor: 1/11; Maximal score (3 months): 29/40 Maximal score (12 months): 33/40	Excellent: 0/14 Good: 8/14 Fair: 5/14 Poor: 1/11; Maximal score (3 months): 22/35 Maximal score (12 months): 25/35	Effect estimate not reported
Mobility	Fernandez 2022 (4, 12 months)	Freely mobile (no aids): 18, 18 Mobile outdoors (one aid): 64, 57 Mobile outdoors (two aids/frame): 102, 78 Indoor only: 134, 113 No mobility: 48, 36 Missing: 244, 308	Freely mobile (no aids): 15, 21 Mobile outdoors (one aid): 61, 70 Mobile outdoors (two aids/frame): 100, 57 Indoor only: 119, 90 No mobility: 54, 43 Missing: 266, 334	Odds ratios: 4 months 0.93 (95% CI; 0.72-1.22), P value 0.610 12 months 1.09 (95% CI; 0.81-1.46), P value 0.556
Discharge destination (Studies did not report data for all categories included in this table)	DeAngelis 2012; Figved 2009; Santini 2005; Taylor 2012	Own home: 43/305 Other medical department: 8/50 Rehabilitation facility: 3/66 Assisted living: 62/66 Geriatric institution: 29/50 Unknown: 1/66	Own home: 50/301 Other medical department: 5/51 Rehabilitation facility: 3/64 Assisted living: 60/64 Geriatric institution: 28/51 Unknown: 1/64	Effect estimate not reported
THA: short stem vs standard stem				

(Continued)

Outcome	Study ID	Short stem: n/N	Standard stem: n/N	Effect estimate as reported by study authors
Mobility	Kim 2012	Walks > 6 blocks with or without aid: 44/72 Walks < 6 blocks: 22/72 Walks indoors only: 6/72	Walks > 6 blocks with or without aid: 40/70 Walks < 6 blocks: 25/70 Walks indoors only: 5/70	Effect estimate not reported
HA: Thompson vs Exeter Trauma Stem				
Mobility	Sims 2018	Freely mobile without aids: 15/242 Mobile outdoors with 1 aid: 38/242 Mobile outdoors with 2 aids/ frame: 19/242 Some indoor mobility but never goes out without help: 135/242 No functional mobility: 35/242	Freely mobile without aids: 16/252 Mobile outdoors with 1 aid: 47/252 Mobile outdoors with 2 aids/ frame: 34/252 Some indoor mobility but never goes out without help: 123/242 No functional mobility: 32/252	Effect estimate not reported

Footnotes:

CI: confidence interval; **n:** number of participants with an event; **N:** total number of participants in group;**RR:** risk ratio

Appendix 7. HAs versus other HAs: data incomplete and not included in analysis

	Measurement tool	Interventions	Study ID	Data for Intervention 1	Data for Intervention 2	Comment
Exeter vs Thompson						
Mobility (**≤ 4 months**)	Parker mobility scale (lower scores indicate better mobility) Follow-up: 3 months	1. Exeter; modern stem; cemented 2. Thompson; traditional stem; cemented	Parker 2012	Mean (change from baseline): 2.2 n = 64	Mean (change from baseline): 1.3 n= 75	No SD P = 0.05
Mobility (**12 months**)	Parker mobility scale (lower scores indicate better mobility) Follow-up: 12 months	1. Exeter; modern stem; cemented 2. Thompson; traditional stem; cemented	Parker 2012	Mean (change from baseline): 1.7 n = 64	Mean (change from baseline): 1.1 n = 75	No SD P = 0.05

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Pain (≤ 4 months)	Degree of residual pain Follow-up: 3 months	1. Exeter; modern stem; cemented 2. Thompson; traditional stem; cemented	Parker 2012	Mean: 1.6 n = 64	Mean: 1.8 n = 75	No SD P = 0.6
Pain (12 months)	Follow-up: 12 months	1. Exeter; modern stem; cemented 2. Thompson; traditional stem; cemented	Parker 2012	Mean: 1.5 n = 64	Mean: 1.6 n = 75	No SD P = 0.8
Length of stay in hospital	LOS (days)	1. Exeter; modern stem; cemented 2. Thompson; traditional stem; cemented	Parker 2012	Mean: 17.6 n = 100	Mean: 17.6 n = 100	No SD P = 1.0
	LOS (days)	1. Exeter; modern stem; cemented 2. Thompson; traditional stem; cemented	Sims 2018	Mean: 9.67 n = 303	Mean: 9.0 n = 315	No SD No P value

HA: hemiarthroplasty
LOS: length of stay in hospital
n: number of analysed participants
SD: standard deviation

Appendix 8. THA versus HA: data incomplete and not included in analysis

	Measurement tool	Interventions	Study ID	Data for Intervention 1	Data for Intervention 1	Comment
Functional status (≤ 4 months)	HHS Follow-up: 3 months	1. THA 2. HA	Cadossi 2013	Mean (range): 24.6 (5 to 40) n = 37	Mean (range): 20.8 (5 to 45) n = 37	No SD P = 0.471
Functional status (12 months)	HHS Follow-up: 12 months	1. THA 2. HA	Cadossi 2013	Mean (range): 26.4 (5 to 45) n = 36	Mean (range): 23.9 (5 to 45) n = 33	No SD P = 0.466
	HHS Follow-up: 12 months	1. THA 2. HA	Sharma 2016	Mean (range): 90 (97 to 95) n = 39	Mean (range): 80 (67 to 85) n = 39	No SD No P value
	HHS (modified) Follow-up: 12 months	1. THA 2. HA	Van den-Bekerom 2010	Mean (range): 76 (44 to 100) n = 115	Mean (range): 73.9 (23 to 100) n = 137	No SD P = 0.40

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Functional status (> 24 months)	HHS Follow-up: 36 months	1. THA 2. HA	Cadossi 2013	Mean (range): 24.7 (5 to 40) n = 16	Mean (range): 28.2 (5 to 45) n = 16	No SD P = 0.417
	HHS (modified) Follow-up: 60 months	1. THA 2. HA	Van den-Bekerom 2010	Mean (range): 75.2 (45 to 96) n = 115	Mean (range): 71.9 (33 to 99) n = 137	No SD P = 0.22
Mobility (≤ 4 months)	Ambulation[a] Follow-up: 3 months	1. THA 2. HA	Dorr 1986	Mean: 4.1 n = 39	Mean: Cemented HA: 4.0; n = 37 Uncemented HA: 3.7; n = 13	No SD No P value
Mobility (12 months)	Ambulation[a] Follow-up: 12 months	1. THA 2. HA	Dorr 1986	Mean: 4.1 n = 39	Mean: Cemented HA: 4.2; n = 37 Uncemented HA: 3.0; n = 13	No SD No P value
Mobility (> 24 months)	Distance walked[b] (km) Follow-up: 36 month	1. THA 2. HA	Baker 2006	Mean (range): 3.6 (0 to 40.2) n = 36	Mean (range): 1.9 (0 to 6.4) n = 33	No SD No P value
Pain (≤ 4 months)	HHS - pain Follow-up: 3 months	1. THA 2. HA	Cadossi 2013	Mean (range): 39.5 (20 to 44) n = 37	Mean (range): 43.7 (30 to 44) n = 37	No SD P = 0.158
	Pain[c] Follow-up: 3 months	1. THA 2. HA	Dorr 1986	Mean: 4.9 n = 39	Mean: Cemented HA: 5.4; n = 37 Uncemented HA: 3.7; n = 13	No SD No P value
Pain (12 months)	HHS - pain Follow-up: 12 months	1. THA 2. HA	Cadossi 2013	Mean (range): 39.5 (20 to 44) n = 36	Mean (range): 43.3 (30 to 44) n = 33	No SD P = 0.006
	Pain[c] Follow-up: 3 months	1. THA 2. HA	Dorr 1986	Mean: 5.5 n = 39	Mean: Cemented HA:	No SD No P value

(Continued)

					5.2; n = 37 Uncemented HA: 3.6; n = 13	
Pain **(> 24 months)**	HHS - pain Follow-up: 36 months	1. THA 2. HA	Cadossi 2013	Mean (range): 40.5 (20 to 44) n = 16	Mean (range): 44 (44 to 44) n = 16	No SD P = 0.073
	HHS - pain Follow-up: 36 months	1. THA 2. HA	Van den-Bekerom 2010	Mean (range): 40.1 (20 to 44) n = 115	Mean (range): 38.6 (10 to 44) n = 137	No SD No P value
Length of stay in hospital	LOS (days)	1. THA 2. HA	Cadossi 2013	Mean (range): 8.7 (4 to 21) n = 41	Mean (range): 9.9 (5 to 21) n = 42	No SD No P value
	LOS (days)	1. THA 2. HA	Parker 2019	Mean: 14.5 n = 52	Mean: 9.2 n = 53	No SD P = 0.055
	LOS (days)	1. THA 2. HA	Van den-Bekerom 2010	Mean (range): 17.1 (2 to 89) n = 137	Mean (range): 18.4 (4 to 86) n = 115	No SD No P value
	LOS (days)	1. THA 2. HA	Iorio 2019	Mean (range): 6.1 (5 to 8) n = 30	Mean (range): 5.5 (5 to 7) n = 30	No SD P > 0.05

[a]Ambulation (6 point scale; higher scores indicate better mobility)

[b]Participant-reported but not specified how this was measured

[c]6-point scale; higher scores indicate less pain

HA: hemiarthroplasty
HHS: Harris hip score
HRQoL: health-related quality of life
LOS: length of stay in hospital
SD: standard deviation
SF-36: Short-Form 36
THA: total hip arthroplasty

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.
MP (content expert, Trauma and Orthopaedics): interpreted the findings, reviewed and approved the final review.
JC (statistician): reviewed and approved the final review.
XG (guarantor and content expert, Trauma and Orthopaedics): interpreted the findings, reviewed and 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.
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 has no known conflicts of interest.
RM has no known conflicts of interest.
MP has received expenses and honoraria from a number of commercial companies and organisations for giving lectures on different aspects of hip fracture treatment. In addition, he has received royalties from BBrawn Ltd related to the design and development of an implant used for the internal fixation of intracapsular hip fractures. He remained independent of study selection decisions, risk of bias assessment, and any data extraction of any of the studies on which he is an author, co-applicant, or has had an advisory role.
JC remained independent of study selection decisions for ongoing studies.
XG is funded by a National Institute for Health Research Clinician Scientist Grant. Further funding from industry and charitable grants are and have been made available to his institution. All decisions relating to the design, conduct, analysis, write-up and publication of research are independent of these funding organisations. He has ongoing expert consultancy with several companies; none involve the development of any implant for use in hip fracture care. He remained independent of study selection decisions, risk of bias assessment, and any data extraction of any of the studies on which he is an author, co-applicant, or has had an advisory role.

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External sources

- NIHR, UK

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  NIHR Cochrane Infrastructure funding to the Cochrane Bone, Joint and Muscle Trauma Group

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Review information

- Review authors: two new review authors joined the review team (SL, RM, JC), and four authors left the review author team (AS, AJ, HW, JMG).

Objectives

- we edited the objectives in line with Cochrane guidance, using a single sentence.

Methods

Criteria for considering studies for this review

- Types of interventions: we specified that the bipolar HA versus unipolar HA was subgrouped by type of cement. We did not organise the interventions groups according to a direction (intervention named first and the control second), because the comparative groups in all studies were for active interventions and did not include control group.

- We did not organise the data by naming the intervention first and the control second. The studies in this review evaluated comparisons between established treatments which are still in active use. In order to keep the interventions distinct and provide relevant information to the reader, we specified the direction of effect in each effect estimate.
- Types of outcome measures: 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 less, 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).

Search methods for identification of studies

- Electronic searches: we did not search the World Health Organization (WHO) 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 collecting "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".
- Measures of treatment effect: we found that some studies reported outcomes using categorical data. We added an explanation of our methods to report effect estimates for these data.
- Unit of analysis issues: we edited this section of the review to describe how we managed potential unit of analysis issues with the included studies. We reported methods for managing multi-arm studies and for managing outcome data in studies that reported participants as well as fracture cases.
- 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 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.
- Assessment of reporting biases: we stated that we required 10 studies to explore publication bias with a funnel plot. We stated that this assessment was therefore only conducted for a few outcomes.
- Data synthesis: we did not pool data using the generic inverse variance method in RevMan 5.4 (Review Manager 2014), because it was not necessary, as we found that study authors reported outcomes that could be pooled appropriately as dichotomous and continuous data. In this section, we added detail to describe how we decided which data to pool in analysis if data were reported at more than one point, and if data were reported using more than one measurement tool.
- Subgroup analysis: we clarified that we conducted subgroup analysis only when we had at least 10 studies. We were unable to explore key effect modifiers because these were insufficiently reported in studies. In this section, we also specified the plan to test for subgroup differences for prostheses according to whether a modern or old uncemented stem was used.
- Sensitivity analysis: we clarified that sensitivity analysis was conducted when pooled analyses included more than two studies. We reported additional detail, for clarity, to describe how we managed sensitivity analysis in the review. We did not perform sensitivity analysis on mixed populations because most studies reported insufficient information for us to judge whether participants' characteristics in the included studies were mixed. We also did not perform sensitivity analysis for studies of implants that are currently not in clinical use. We obtained the general view that all interventions at the major-grouping level remain in current use, and although some examples of implants within these categories may no longer be manufactured, we believe the distinction between these implants within the same category is marginal and the sensitivity analysis would not be meaningful.
- Summary of findings: we specified the comparison groups for which we constructed summary of findings tables. We also explained a choice to select one measurement tool for the summary of findings tables when outcomes were reported using different measurement tools or measurement values that could not all be combined in meta-analysis.

INDEX TERMS

Medical Subject Headings (MeSH)

Activities of Daily Living; *Arthroplasty, Replacement, Hip [adverse effects]; *Hip Fractures [surgery]; Hip Joint [surgery]; Quality of Life

MeSH check words

Aged; Female; Humans; Middle Aged