Cemented versus uncemented arthroplasty for the management of femoral neck fractures in the elderly

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Abstract

Background

Hemiarthroplasty and total hip arthroplasty (TKA) are commonly used to treat unstable femoral neck fractures in older patients. However, there is no consensus on the use of cement during hemiarthroplasty and TKA. Previous reviews on this subject included small number of studies and lacked evidence grading of outcomes. In this study, we aimed to compare the outcomes of cemented and uncemented arthroplasty for the treatment of femoral neck fractures in older patients.

Methods

A meta-analysis was conducted according to the guidelines of the Cochrane Collaboration using online databases (Pubmed, Cochrane Central Register of Controlled Trials, and Ovid). The quality of the included studies was assessed using the Cochrane Collaboration tool and Newcastle-Ottawa Scale. Prospective cohort studies and randomized controlled trials (RCT) of cemented arthroplasty versus uncemented arthroplasty for treatment of femoral neck fractures were analyzed using Review Manager (version 5.2) software.

Results

Sixteen studies were included in the meta-analysis. Cemented arthroplasty was found to be superior to uncemented arthroplasty with respect to reoperation rate, complications related to prosthesis, residual pain, and operation time. There were no significant between-group differences with respect to local and general complications, duration of hospital stay, hip function, and mortality.

Conclusion

Compared with cemented arthroplasty, uncemented arthroplasty was associated with a greater risk of complications related to prosthesis, reoperation rate, residual pain, and longer operation time. However, the results of this meta-analysis should be interpreted cautiously owing to some limitations. Further studies are required to provide more robust evidence.

Background

Femoral neck fractures account for approximately 57% of hip fractures and represent a rising problem in our aging society. The condition affects the quality of life and imposes a considerable social and personal medical burden [1]. Hemiarthroplasty and TKA are commonly used for treatment of unstable femoral neck fractures in older patients [2]. However, there is no clear consensus on the use of cement during these procedures, and periprosthetic fracture, reoperation and mortality were reported differently for cemented and uncemented arthroplasty.

For cemented arthroplasty, polymethylmethacrylate cement is used to create a solid bone-implant interface. Some previous studies suggest that cemented arthroplasty may decrease the incidence of dislocation and loosening, facilitate early mobilization of hip movement, and improve postoperative hip function [3–5]. However, in other studies, use of cement was shown to increase intraoperative mortality or perioperative mortality due to cardiovascular disease; in these studies, cardiac output and stroke volume was decreased by 33% and 44%, respectively [6, 7].

In uncemented arthroplasty, initial implant rigidity is achieved via press-fit technique. The bond between the stem and femur is dependent on osseous integration [8]. However, the poor quality of bone in elderly patients may lead to many periprosthetic fractures [9].

Some randomized controlled trials (RCTs) and systematic reviews have also found differences between the outcomes of cemented and uncemented arthroplasty. In the study by Furnes et al, the incidence of reoperation after uncemented arthroplasty was higher than that after cemented arthroplasty [10]. In the study by Li et al, no significant difference was observed between cemented and uncemented arthroplasty with respect to mortality, reoperation rate, and fatal vascular disease; however, there was a higher risk of poor hip function and residual pain in the uncemented arthroplasty group [9]. Luo et al also observed a similar reoperation rate, mortality, and incidence of complications in the two groups [11]. In the study by Ning et al [12], residual pain was similar between the two groups; however, this finding was inconsistent with those of other two studies [13, 14]. Although many studies have compared the two treatments, these studies had some limitations. First, the sample size of the enrolled studies was small and many new published studies were not included. Second, some previous studies did not assess publication bias or evidence grading of outcomes. Third, some retrospective studies were included in the previous analysis, which provide low-quality evidence.

To provide more robust evidence for the treatment of femoral neck fractures in older patients (age > 65 years), we conducted an updated systematic review and meta-analysis to compare the effectiveness and safety of cemented and uncemented arthroplasty.

Methods

Eligibility criteria and literature search

We searched for relevant studies in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (PRISMA) [15]. Studies that compared cemented versus uncemented arthroplasty for femoral neck fractures in older patients were searched in online databases including Pubmed, Cochrane Central Register of Controlled Trials, and Ovid. Studies published as of July 2019 were eligible for inclusion. The following medical subject heading (Mesh) were used to retrieve studies: "Femoral neck fractures," "femoral fractures," "hip," "arthroplasty," "replacement," "cemented," "uncemented," "randomized controlled trial (RCT)," and "prospective."

The inclusion criteria for this meta-analysis were: (1) patients (age > 65 years) diagnosed with femoral neck fracture; (2) intervention: patients treated by cemented hemiarthroplasty and THA; (3) comparison treatment: patients treated by uncemented hemiarthroplasty and THA; (4) outcomes: mortality, complications, reoperation, residual pain, hip function as assessed using hip harris score, operation time, and duration of hospital stay; (5) RCTs or prospective cohort trials were included; and (6) language of publication limited to English. The exclusion criteria were (1) duplicate publications, systematic reviews, case reports, and retrospective studies; (2) studies for whom full-text was not available; (3) presence of pathological fractures.

Outcomes of interest

The primary outcomes of this meta-analysis were incidence of mortality, complications, and reoperation. We divided complications into three categories: complications related to prosthesis, local complications, and general complications. Periprostheses loosening, dislocation, and subsidence were included in complications related to prosthesis. Local complications included wound infection, hematoma, and heterotopic ossification. General complications included cerebrovascular and cardiovascular complications, urinary infection, bedsores, pneumonia, and renal failure. The secondary outcomes were residual pain, hip harris score for hip function, operation time, and duration of hospital stay.

Data extraction and quality assessment

Data pertaining to study design, age, sex, type of prosthesis, follow-up, and outcomes were independently extracted by two researchers. The quality of the included studies was assessed using the Cochrane Collaboration recommendations for RCTs [16] and Newcastle-Ottawa Scale for prospective cohort studies [17]. The recommendations of Cochrane Collaboration include assessment of the following: random sequence generation (selection bias), allocation concealment (selection bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective reporting (reporting bias), and other sources of bias. The Newcastle-Ottawa Scale score for patient selection, comparability, and outcomes are shown in S1 Table. The total score is eight; the higher the score, the greater is the quality of cohort studies. In addition, the Graderpro (version 3.6) was used to assess the grading for every meta-analysis in this review. According to the design, risk of bias, inconsistency, indirectness, and imprecision, the grading was divided into high, moderate, and low. The higher the grade, the greater is the quality.

Statistical analysis

Review Manager software (Version 5.2, The Nordic Cochrane Centre, The Cochrane Collaboration, 2012) was used for statistical analysis. Mean differences (MD) and 95% confidence intervals (CI) were calculated for continuous outcomes, and relative risk (RR) and 95% CI were calculated for dichotomous outcomes. Fixed-effect models were used when the $I^2 < 50\%$ and random-effect models were used when heterogeneity existed ($I^2 > 50\%$). Sensitivity analysis was conducted when $I^2 > 50\%$. Publication bias was also conducted by Review Manager (version 5.2). A P value < 0.05 was considered statistically significant.

Results

Characteristics and qualities of the studies included

A flow diagram of the study according to the PRISMA statement was shown in Fig. 1. 421 studies were obtained by Pubmed ($n = 204$), Cochrane Central Register of Controlled Trials ($n = 71$), Ovid ($n = 144$) and other additional studies ($n = 2$). After duplication and reading full-text, sixteen studies were enrolled in this review. Among the sixteen studies, twelve of them were RCT [13, 14, 18–27] and four of them were prospective cohort studies [3, 28–30]. There were 2180 hips analyzed in the 16 studies: 1087 hips for cemented arthroplasty and 1093 hips for uncemented arthroplasty. The 16 studies were showed in English and the full-text available. The detailed characteristics of included studies were shown in Table 1. There was a low risk bias for the RCTs included. Eight studies had adequate random sequence regeneration: two computer regeneration [13, 18] and six envelope regeneration [14, 20–23, 27]. Eight studies mentioned allocation concealment [13, 14, 18, 20–23, 27]. Of the sixteen studies, eight studies used observed blinding [13, 14, 18, 19, 22, 23, 26, 27], ten studies reported complete outcome

[13, 14, 18–23, 25, 27], and ten studies reported all outcome data without reporting bias [13, 14, 18–23, 25, 27]. For prospective cohorts, three studies received eight score points [3, 28, 30] and one study received seven score points [29]. The details were shown in Fig. 2 and Table 2.

Table 1
Characteristics of the studies included

Included study	Type	Mean age (year) (C/UC)	Treatment (C/UC)	Gender (Male/female)	Type of operation	Type of prosthesis(C/UC)	Follow-up	Outcome
Emery 1991[20]	RCT	78.0/79.6	27/26	53(7/46)	Hemiarthroplasty	Thompson/Austin Moore	17-18m	□□□□□
Santini 2005[25]	RCT	82.09/79.68	53/53	106(24/82)	Hemiarthroplasty	Bipolar endoprosthesis/Bipolar endoprosthesis	12 m	□□□□
Parker 2010[14]	RCT	83/83	200/200	400(308/92)	Hemiarthroplasty	Thompson/Austin Moore	60 m	□□□□□□
Taylor 2012[13]	RCT	85.3/85.1	80/80	160(50/110)	Hemiarthroplasty	Exeter/ Alloclassic	24 m	□□□□□□
Deangelis 2012[19]	RCT	82.8/81.8	64/61	130(30/100)	Hemiarthroplasty	LD/Fx/ Beaded FullCoat	12 m	□□□□
Sadr and Arden 1977[24]	RCT	77.0/78.4	20/20	40(10/30)	Hemiarthroplasty	Thompson/Thompson	3-17m	□□□□
Sonne-Holm 1982[26]	RCT	76	55/57	112(37/75)	Hemiarthroplasty	Austin Moore/Austin Moore	12 m	□□□□
Singh 2006[3]	PC	84/83	25/29	54(8/46)	Hemiarthroplasty	Thompson/Austin Moore	12 m	□□□
Chammout 2017[18]	RCT	72/73	35/34	69(22/47)	THA	THA	24 m	□□□□
Gavaskar 2013[30]	PC	84.2/84	31/31	62(32/30)	THA	THA	24–46 m	□□□□□□
Inngul 2015[21]	RCT	81.2/81.3	67/74	141(42/99)	Hemiarthroplasty and THA	Exeter/hydroxyapatite coated Bimetric	12 m	□□□□□
Khorami 2016[29]	PC	79.0/71.7	22/29	51(19/32)	Hemiarthroplasty	bipolar/bipolar	18-20m	□□
Langslet 2014[22]	RCT	83.4/83	112/108	223(NA/NA)	Hemiarthroplasty	Spectron/ HA-coated	60 m	□□□□□□□
Talsnes 2013[27]	RCT	84.0/84.3	162/172	334(85/249)	Hemiarthroplasty	Bipolar implants/Bipolar-implants	12 m	□□
Prashanth 2017[28]	PC	70	24/28	52(22/30)	Hemiarthroplasty	Bipolar/Bipolar	12 m	□□□□
Sophie 2017[23]	RCT	83/84	110/91	201(58/143)	Hemiarthroplasty	Müller Straight Stem/type DB-10	12 m	□□□□□
C: cemented; UC:uncemented;PC:prospective cohort;□operation time□hospital stay□mortality□complication □reoperation rate□residual pain□hip function								

Table 2
Newcastle-Ottawa Scale of prospective cohort studies

Author group	Selection				Comparability	Outcome		
	Representativeness of the exposed cohort	Selection of the non exposed cohort	Ascertainment of exposure	outcome was not present at start of study	Comparability of controls	Ascertainment of exposure	follow-up long enough	Adequacy of follow up

Singh 2006[3]	1	1	1	1	1	1	1	1
Gavaskar 2013[30]	1	1	1	1	1	1	1	1
Khorami 2016[29]	1	1	1	1	1	1	-	1
Prashanth 2017[28]	1	1	1	1	1	1	1	1

Mortality

Thirteen studies enrolling 1998 hips reported mortality (Fig. 3). With respect to mortality within three months after operation, no significant difference was observed between the cemented group (11.7%, 101/860) and the uncemented group (11.7%, 103/877) [RR 0.99, 95% confidence interval (CI) 0.77–1.28], $P = 0.96$] using the fixed-effect model ($I^2 = 0\%$). Similarly, with respect to mortality at last follow-up, no significant difference was observed between the cemented group (36.2%, 362/1001) and the uncemented group (36.9%, 368/997) (RR 0.97, 95% CI 0.88–1.08, $P = 0.63$, $I^2 = 0\%$).

Complications

Fifteen studies enrolling 1851 hips reported complications (Fig. 4). The event rate for complications related to prosthesis was 3.2% (24/755) in the cemented group and 12.4% (93/749) in the uncemented group; the between-group difference in this respect was statistically significant (RR 0.27, 95% CI 0.17–0.41, $P < 0.00001$, $I^2 = 41\%$). However, no significant between-group difference was observed with respect to incidence of local complications (RR 0.97, 95% CI 0.73–1.29, $P = 0.84$) or general complications (RR 0.99, 95% CI 0.82–1.18, $P = 0.88$).

Reoperation rate

Eleven studies enrolling 1640 hips reported reoperation rate (Fig. 5A). The duration of follow-up in the ten studies ranged from 3 to 60 months. The reoperation rate was 3.2% (26 of 823) in the cemented group and 5.8% (47 of 817) in the uncemented group. The fixed-effect model has been used since there was no heterogeneity ($I^2 = 0\%$). There was a significant difference between the cemented group and the uncemented group (RR 0.57, 95% CI 0.37–0.90, $P = 0.02$).

Residual pain

Seven studies enrolling 698 hips were analyzed for residual pain within two years after operation (Fig. 5B). The data showed that there was no significant difference between the cemented group and the uncemented group [RR 0.66, 95% CI (0.52–0.83, $P = 0.0004$). Owing to lack of significant heterogeneity ($I^2 = 0\%$), the fixed-effect model was used for meta-analysis.

Hip function

Five studies enrolling 387 hips assessed hip function using the HHS (Fig. 5C). Owing to significant heterogeneity among these studies ($I^2 = 55\%$), a random-effect model was used for meta-analysis. No significant between-group difference was observed with respect to hip function

(RR -0.67, 95% CI -4.52–3.18, $P = 0.73$). On sensitivity analysis, one study [22] was found to contribute to the heterogeneity (Fig S1A). After exclusion of this study, similar results were obtained for the two groups ($P = 0.32$).

Operation time

Ten studies enrolling 1675 hips had reported the operation time (Fig. 6A). Owing to significant heterogeneity among these studies ($I^2 = 99\%$), the random-effect model was used for meta-analysis. The operation time in the uncemented group was significantly shorter than that in the cemented group [mean difference (MD) 11.70, 95% CI 0.42–22.98, $P = 0.04$]. On sensitivity analysis, one study [30] was found to be a major contributor to heterogeneity (Fig S1B). After exclusion of this study, operation time in the uncemented group was still significantly lower but with lesser heterogeneity among the included studies (MD 8.01, 95% CI 6.18–9.85, $P < 0.00001$, $I^2 = 39\%$).

Hospital stay

Eight studies enrolling 1235 hips reported on the duration of hospital stay (Fig. 6B). No significant difference was observed between the cemented group and the uncemented group using the random-effect model (MD 0.36, 95% CI -1.16–1.87, $P = 0.65$, $I^2 = 78\%$). On sensitivity analysis, one study [30] was found to contribute to the heterogeneity (Fig. S1C). After exclusion of this study, no significant difference was observed between the two groups with no heterogeneity (MD -0.04, 95% CI -0.78-0.70, $P = 0.92$, $I^2 = 0\%$).

GRADE assessment and publication bias

A summary quality assessment using the GRADE system (Grading of Recommendations Assessment, Development and Evaluation) was conducted (Fig. 7). The quality was high for the outcomes of operation time, complications related to prosthesis, and residual pain. For the outcomes of reoperation rates, general complications, and mortality at last follow-up, the quality of evidence was moderate. There was low quality of evidence pertaining to the hospital stay, local complication, hip function, and mortality within 3 months. No obvious publication bias was detected for complications (Fig. 8).

Discussion

Arthroplasty is currently the gold standard for treatment of femoral neck fractures in older patients. It is known to help improve the quality of life of patients. However, there is no consensus on the use of cement during arthroplasty. In this study, we synthesized evidence from 16 studies that compared cemented with uncemented arthroplasty for treatment of femoral neck fractures in older patients. We found that cemented arthroplasty was superior to uncemented arthroplasty with regards to the reoperation rate, complications related to prosthesis, and residual pain; however, the former required longer operation time. There was no significant difference between the two procedures with respect to mortality, duration of hospital stay, hip function, or general and local complications.

Compared with previous systematic reviews [9, 11, 12, 31–34], our meta-analysis improved certain aspects and provided some new insights. First, a larger sample of studies (16 studies) was included in our analysis, which helped decrease the selection bias. Second, the need for reoperation is a key concern both for surgeons and patients; previous systematic reviews including one latest review [35] found no differences between the two treatments with respect to reoperation rate. However, after inclusion of larger number of studies with longer follow-up period, we found that cemented arthroplasty may significantly decrease the reoperation rate; this finding is different from those reported by Li et al [9] and Luo et al [11]. Third, we included only RCTs and prospective cohort studies, which yielded higher quality data. Fourth, we performed subgroup analysis and sensitivity analysis and explored potential factors that may have affected our results. Fifth, half of the included studies had a follow-up period of more than two years, which provided more robust evidence with respect to reoperation rate, mortality, residual pain, and hip function. Lastly, each outcome was assessed using the GRADE system.

Based on analysis of reoperation data from eleven studies, uncemented arthroplasty was associated with a significantly higher reoperation rate (5.8%) as compared to cemented group (3.2%). The higher reoperation rate after uncemented arthroplasty may be attributable to loosening of the prosthesis, intraoperative fracture, or dislocation. This outcome was different from previous systematic reviews [9, 11, 36, 37] where researchers found no significant differences between the cemented and uncemented groups. The difference may be due to a larger sample size and longer follow-up period in our study.

We also observed a significant difference between the cemented and uncemented groups with respect to the incidence of complications. There was significant heterogeneity and subgroup analysis was conducted ($I^2 = 93.6\%$). Complications related to prosthesis were less frequent in the cemented group, which is supported by previous studies [9]; this may explain the higher reoperation rate in the uncemented group. Local and general complications in the cemented group were also less frequent than those in the uncemented group, although the between-group difference was not statistically significant. These findings are consistent with those of previous studies [12, 30, 38].

Mortality is another key concern in patients with femoral neck fracture. Thirteen studies were analyzed and the rate of mortality was comparable in the two groups. Many studies support our findings [12, 27]. In the study by Talsnes et al, the hazard ratio was 0.77 with no significant difference in mortality after long-term follow-up ($p = 0.233$). However, a study conducted in 1994 showed that use of cement may increase the intraoperative mortality rate due to the increased risk of cardiovascular disease on insertion [39]. In our study, one patient developed heart failure [21] and three patients developed cardiac arrest or myocardial infarction and died within 72 hours after cemented arthroplasty [13, 40]. The age of patients and preexisting cardiopulmonary symptoms may also affect the mortality rate [41].

Residual pain and hip function are key determinants of the quality of life of patients. In our study, cemented arthroplasty was significantly associated with less postoperative pain and similar hip function compared to uncemented group. This finding is consistent with the results reported by Ning et al and Bagaric et al [12, 32]. In the study by Figved et al, residual pain in the cemented group was greater than that in the uncemented group, although the difference was not statistically significant. This difference may be attributable to the different materials (hydroxyapatite-coated) used in the study populations included in the respective reviews. For analysis of HHS, there was significant heterogeneity among the included studies (55%); based on the results of sensitivity analysis, exclusion of one study [22] from the meta-analysis eliminated the heterogeneity ($I^2 = 0\%$). On further review of the literature, we found that in the study by Langslet et al, the HHS was significantly different between the two groups only in the fifth year. However, less than half of the original study population was followed-up. The heterogeneity may be attributable to the large number of patients who were lost to follow-up.

Our study demonstrated that cemented arthroplasty increases the operation time and this could be related to the additional procedures for cement insertion, which is consistent with many previous studies [18, 27, 29, 38]. With respect to the duration of hospital stay, our study found no significant difference between cemented and uncemented arthroplasty, which is consistent with Ning et al [12]. There was significant heterogeneity among the studies included in the meta-analysis of operation time and duration of hospital stay. Among these studies, data from the study by Gavaskar et al [30] was very concentrated with a very small standard deviation. Based on the results of sensitivity analysis, exclusion of the study by Gavaskar et al [30] reduced the heterogeneity among the remaining studies. Thus our results were credible.

Several limitations of our study should be considered while interpreting the results. First, some unpublished studies and non-English language studies were not included in our study, which could lead to bias. Second, information pertaining to random sequence generation and allocation concealment was not available for many of the included studies, which may lead to misjudgment of the quality. Third, the included studies involved the use of many different types of prosthesis; this may have introduced an element of bias. Further analysis is required to provide stronger evidence for clinical treatment.

In our meta-analysis, we used the GRADE system to assess the evidence grading of the outcomes. The quality of evidence pertaining to the outcomes of reoperation rate, operation time, complications related to prosthesis, general complications, mortality, and residual pain was high or moderate. However, the evidence grading for hospital stay and local complications was low due to the following reasons. First, four of the included studies [3, 28–30] were prospective cohort studies and not RCTs. Second, the 95% confidence intervals around relative effects were very wide (range, 0.73–1.29) or there was considerable heterogeneity.

Conclusion

In summary, our study compared the outcomes of cemented and uncemented arthroplasty for femoral neck fractures in older patients. Our results suggest that cemented arthroplasty may help decrease reoperation rate and the incidence of complications related to prosthesis, and reduce residual pain. However, owing to the study limitations, there is a need for more high quality studies involving longer follow-up period to provide more definitive evidence.

Abbreviations

RCT; randomized controlled trial; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Declarations

Ethics approval consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no conflict of interest.

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Authors' contributions

XYT supervised the conception and design of the meta-analysis. LL participated in the meta analysis of each result and critically revised the manuscript. XDY critically revised the manuscript. JJ, LY and FX participated in the collection and analysis of the study data. All authors approved the final manuscript

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Supporting Information

S1 Table. Newcastle-Ottawa Scale. (Docx)

S2 Table PRISMA 2009 checklist.

S1 Figure. sensitivity analysis of (A) hip function, (B)operation time, and (C)hospital stay.

Figures

PRISMA 2009 Flow Diagram

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Figure 1

Flow chart detailing the selection of the studies included for the meta- analysis.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Chammout 2017	+	+	+	+	+	+
Deangelis 2012	?	?	+	+	+	+
Emery 1991	+	+	?	+	+	+
Inngul 2015	+	+	-	+	+	+
Langslet 2014	+	+	+	+	+	+
Parker 2010	+	+	+	+	+	+
Sadr and Arden 1977	?	?	?	?	?	?
Santini 2005	?	?	?	+	+	+
Sonne-Holm 1982	?	?	+	-	?	?
Sophie 2017	+	+	+	+	+	+
Talsnes 2013	+	+	+	+	+	+
Taylor 2012	+	+	+	+	+	+

Figure 2

Quality assessment of risk of bias in the studies included.

Figure 3

Forest plot of relative risk with confidence intervals for mortality.

Figure 4

Forest plot of relative risk with confidence intervals for complication.

Figure 5

Forest plot of relative risk with confidence intervals for reoperation rate(A), residual pain (B), and hip function (C).

Figure 6

Forest plot of relative risk with confidence intervals for operation time (A), and hospital stay (B) .

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Cemented	Uncemented	Relative(95% CI)	Absolute		
operation time (follow-up 12-60 months)												
10	randomised trials	serious ¹	serious ²	no	serious ³	none	833	842	-	MD 11.70 higher (0.42 to 22.98 higher)	⊕○○○ LOW	IMPORTANT
Sensitivity analysis of operation time (follow-up 12-60 months)												
9	randomised trials	no	no	no	no	none	802	811	-	MD 8.01 higher (6.18 to 9.85 higher)	⊕⊕⊕⊕ HIGH	IMPORTANT
Hospital stay (follow-up 12-60 months)												
8	randomised trials	serious ¹	serious ²	no	serious ³	none	626	609	-	MD 0.36 lower (1.16 lower to 1.87 higher)	⊕○○○ LOW	IMPORTANT
Sensitivity analysis of hospital stay (follow-up 12-60 months)												
7	randomised trials	serious ¹	no	no	serious ³	none	595	578	-	MD -0.04 lower (0.78 lower to 0.70 higher)	⊕⊕○○ LOW	IMPORTANT
Reoperation rate(follow-up 3-60 months)												
11	randomised trials	serious ¹	no	no	no	none	26/823	47/817	RR 0.57 (0.37 to 0.90)	25 fewer per 1000 (from 6 more to 36 more) ¹	⊕⊕⊕○ MODERATE	CRITICAL
Complication - Complication related to prosthesis (follow-up 3-60 months)												
12	randomised trials	serious ¹	no	no	no	strong association ⁴	24/755	93/749	RR 0.27 (0.17 to 0.41)	91 fewer per 1000 (from 73 fewer to 103 fewer)	⊕⊕⊕⊕ HIGH	CRITICAL
Complication - Local complication (follow-up 3-60 months)												
16	randomised trials	serious ¹	no	no	serious ⁵	none	80/927	81/924	RR 0.97 (0.73 to 1.29)	3 fewer per 1000 (from 24 fewer to 25 more)	⊕⊕○○ LOW	IMPORTANT
Complication - General complication (follow-up 12-60 months)												
12	randomised trials	serious ¹	no	no	no	none	170/828	164/819	RR 0.99 (0.82 to 1.18)	2 fewer per 1000 (from 36 fewer to 36 more)	⊕⊕⊕○ MODERATE	IMPORTANT
Resident pain(within 2 years) (follow-up 3-60 months)												
7	randomised trials	no	no	no	no	none	83/360	118/338	RR 0.66 (0.52 to 0.83)	119 fewer per 1000 (from 59 fewer to 168 fewer)	⊕⊕⊕⊕ HIGH	IMPORTANT
Hip function(follow-up 12-60 months)												
5	randomised trials	serious ¹	serious ²	no	serious ³	none	190	197	-	MD 0.67 lower (4.52 lower to 3.18 higher)	⊕○○○ LOW	IMPORTANT
Sensitivity analysis of hip function(follow-up 12-46 months)												
4	randomised trials	serious ¹	no	no	serious ³	none	149	160	-	MD 1.22 lower (-1.18 to 3.62 higher)	⊕⊕○○ LOW	IMPORTANT
Mortality - Mortality(within 3 months) (follow-up 3-60 months)												
11	randomised trials	serious ¹	no	no	serious ⁵	none	101/860	103/877	RR 0.99 (0.77 to 1.28)	1 more per 1000 (from 27 fewer to 33 more)	⊕⊕○○ LOW	CRITICAL
Mortality - Mortality(last follow-up) (follow-up 3-60 months)												
14	randomised trials	serious ¹	no	no	no	none	362/1001	368/997	RR 0.97 (0.88 to 1.08)	11 more per 1000 (from 44 fewer to 30 more)	⊕○○○ MODERATE	CRITICAL
¹ This outcome contained some prospective studies (Gavaskar 2013, Singh 2006, Prashanth 2017 and Khorami 2016), which were not RCT												
² The heterogeneity of 12 was more than 50%												
³ The upper or lower of 95% confidence interval confidence crossed an effect size of 0.5												
⁴ The RR was a magnitude of effect(RR 0.27)												
⁵ The 95% confidence intervals around relative effects could be very wide												

Figure 7

Summary of outcome and evidence grading

Figure 8

Publication bias.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [S1Figure.tif](#)
- [S1TableNewcastleOttawaScale.docx](#)
- [S2TablePRISMA2009checklist.doc](#)