



Hemiarthroplasty for neck of femur fractures: to cement or not? A systematic review of literature and meta-analysis

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Abstract

Background Management of fractures of neck of femur in the elderly is largely joint sacrificing, with hemiarthroplasties being the most common entity used. Cemented and uncemented, both the techniques, are universally accepted; however, the former has been more time tested, despite its theoretical disadvantage in the form of cement embolism leading to intra-operative complications. Uncemented stems have been ever evolving with newer designs to increase incorporation, stability and durability. They have their own reported sets of disadvantages like subsidence and fractures. However, overall there is no established gold standard out of the two.

Objective The present systematic review and meta-analysis of current literature was conducted, so as to determine the superiority of one technique over the other by comparing the primary outcomes like hip function, residual pain, local and general complications and mortality. Additionally secondary outcomes like duration of surgery, blood loss and re-operations were analysed as well.

Methodology Three databases of PubMed, EMBASE and SCOPUS were searched for relevant articles of last 10 years that directly compare uncemented and cemented hemiarthroplasties, and based on our inclusion and exclusion criteria, article selection was done.

Results We analysed a total of six randomised controlled studies dated from 2008 to 2017.

Primary outcomes There was a significant difference in post-operative ability to ambulate at 1 year, between 2 groups with odds ratio 0.45 (95% CI 0.29–0.67, $p = 0.0001$) favouring cemented hemiarthroplasty. Prosthesis-related complications like fractures and subsidence and general complications like lung complications were more in uncemented group. Mortality at 1 year was more in cemented group.

Secondary outcomes Mean surgical time was lesser in uncemented cases. There was no difference in blood loss and re-operation rates.

Conclusion Cementing techniques are here to stay, until a better, durable and more stable uncemented stem evolves, that could lessen the complications related to uncemented surgeries and match the cemented implants in pain relief and ambulation.

Keywords Hemiarthroplasty · Cemented · Uncemented · Outcomes · Neck femur fractures · NOF · Complications

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Introduction

Fractures around hip are common in the elderly, often occurring due to trivial falls, due to poor eye sight and loss of balance and coordination in the age group. Due to prevalent osteoporosis in these patients, their bones are weak and even trivial falls from standing heights lead to these fractures; that include the neck of femur (NOF) fractures and the intertrochanteric femur fractures [1, 2]. These patients often have associated co-morbidities; therefore, early fixation and mobilisation is of paramount importance to prevent associated morbidity and mortality [3]. In the elderly, hemiarthroplasty as treatment of neck femur is a widely accepted surgery, due to its advantage of providing early ambulation with lower chances of failure and need for re-operations, as well as good overall functional outcome [4, 5].

In terms of design, both cemented and uncemented stems are available for hemiarthroplasty, both of which have proven efficacy. However, with their own sets of merits and demerits, superiority of one over the other is not conclusive. Uncemented stems, that act by press-fit technique, theoretically have advantages of easier surgical procedure and lesser duration of surgery but also are known to possess risk of periprosthetic fractures and thigh pain with implant loosening due to poor osteointegration with the osteoporotic bone [6].

On the other hand, use of a cemented stem achieves better implant fixation due to the cement that enhances the anchorage, with lesser chances of loosening and thigh pain but have high risks of cardiovascular and respiratory complications due to cement-related toxicity and embolisation of cement monomer, the so-called cement disease [7, 8]. Revision surgeries also become very difficult in cemented cases [9].

Although reviews have been previously done, but with ever evolving stem designs, periodical analysis is a necessity to build a clear-cut consensus regarding the better choice of stems between the two types [5, 10, 11]. These reviews are older studies mainly utilising the now shelved implant designs or old mono-block designs like Thompson or Moore's prosthesis, that are not in much usage now [5]. The last meta-analysis published was way back in the year 2013, with all the articles dating much before that and 4 of which included Austin Moore and Thompson prosthesis [10].

The present study was conceptualised in order to review the most recent literature that includes newer state-of-the-art stems, with the aim to assess the present evidence. We have only included prospective randomised controlled studies (RCTs) of the last 10 years, that incorporate the most recent advances in the implant design and properties that theoretically enhance osteointegration in cementless stems.

We included primary outcomes as post-operative hip function, residual pain at 1 year, complications and 1-year

mortality. Different studies used different scoring systems to measure post-operative hip function, so we used patient's ability to ambulate with any aid as the parameter which is common among the studies. Complications were divided into four categories: implanted-related complications like intra-operative and post-operative periprosthetic fractures, prosthesis loosening and dislocations; local complications like superficial or deep wound infections; general complications like pneumonia, urinary tract infection, bedsores, gastrointestinal bleed and acute renal failure, etc. Re-operation rates, surgical time and intra-operative blood loss were defined as secondary outcomes.

Methods

Search methodology

We designed the study according to the guidelines of the preferred reporting items for systematic reviews and meta-analysis (PRISMA) [12].

Three databases of PubMed, EMBASE and SCOPUS were searched on 8th and 9th February 2018 using the keywords as depicted in Table 1, from last 10 years. A total number of 2696 hits were obtained. We also performed a secondary search from the references from all the articles selected as per the predefined criteria.

Inclusion and exclusion criteria

Randomised controlled studies (RCTs) published during last 10 years, including patients with average age of over 65 years, comparing the outcomes of cemented and uncemented hemiarthroplasties done for intracapsular neck of femur (NOF) fractures, were analysed. Cadaveric studies, conference abstracts, case reports and any studies that included other proximal femur fractures were all excluded. We also excluded non-English articles and systematic reviews. Articles describing older implants like Thompson and Moore's prosthesis were also excluded.

Data collection and analysis

Two reviewers (P.K. and R.K.R) independently screened the studies. The title of the present study was utilised to assess the articles that seemed fit for inclusion, and their abstracts were read. In case of any confusion that cropped up during abstracts screening, full texts were accessed and studied. The articles that pertained to the study question were identified and finally these short-listed articles were included in the review for the analysis. Any selection conflicts between the two authors were resolved by discussion involving the other co-authors to arrive at a final consensus.

Table 1 Search strategy used for the systematic review in PubMed, EMBASE and SCOPUS databases

Database	Period—2008 to 9th February 2018	Results
<i>PubMed</i>		
1. Hemiarthroplasty		2619
2. 1 AND (“dental cementum”[MeSH Terms] OR (“dental”[All Fields] AND “cementum”[All Fields]) OR “dental cementum”[All Fields] OR “cemented”[All Fields]) AND uncemented[All Fields]		102
3. 1 AND (“dental cementum”[MeSH Terms] OR (“dental”[All Fields] AND “cementum”[All Fields]) OR “dental cementum”[All Fields] OR “cemented”[All Fields]) AND uncemented[All Fields] AND (“neck”[MeSH Terms] OR “neck”[All Fields]) AND (“femoral fractures”[MeSH Terms] OR (“femoral”[All Fields] AND “fractures”[All Fields]) OR “femoral fractures”[All Fields] OR (“femur”[All Fields] AND “fracture”[All Fields]) OR “femur fracture”[All Fields])		72
4. 1 AND (“dental cementum”[MeSH Terms] OR (“dental”[All Fields] AND “cementum”[All Fields]) OR “dental cementum”[All Fields] OR “cemented”[All Fields]) AND uncemented[All Fields] AND (“neck”[MeSH Terms] OR “neck”[All Fields]) AND (“femoral fractures”[MeSH Terms] OR (“femoral”[All Fields] AND “fractures”[All Fields]) OR “femoral fractures”[All Fields] OR (“femur”[All Fields] AND “fracture”[All Fields]) OR “femur fracture”[All Fields]) AND outcome[All Fields]		44
<i>Embase</i>		
Hemiarthroplasty AND cemented AND uncemented AND (‘neck’/exp OR neck) AND (‘femur’/exp OR femur) AND (‘fracture’/exp OR fracture) AND (‘outcome’/exp OR outcome)		23
<i>Scopus</i>		
TITLE-ABS-KEY (hemiarthroplasty AND cemented AND uncemented AND neck AND femur AND fracture AND outcome)		54

Data extracted were collected and registered on a structured form under two groups (Group 1—Cemented hemiarthroplasty or CH and Group 2—Uncemented hemiarthroplasty or UH). This included names of the authors and the journal, year of publishing, demographic parameters like age, sex and number of patients, intra-operative or post-operative complications like blood loss, infection or implant-related issues, functional outcomes, etc. This was summarised in tabular form (Tables 2, 3).

Quality assessment

Studies that met inclusion criteria were assessed with Jadad scale scoring system [13]. Studies with a score of 3 were considered as high quality. Four of the included studies were of high quality. All studies were then assessed by two independent reviewers (VK and DN) to check the methodological quality of clinical trials using Cochrane Collaboration recommendations. Aspects like random sequence

Table 2 Preoperative data in the studies

Serial no.	Authors	Year	Type of study	Groups (1—CH, 2—UH)	No. of patients	Percentage of females (%)	Mean age (years)	Final follow-up (months)	ASA score (1, 2, 3, 4)
1	Figved et al. [14]	2009	RCT	CH	112	78	83.4	12	Group 1, 2:42%
				UH	108	74	83		44%
2	DeAngelis et al. [15]	2012	RCT	CH	66	78.8	81.8	12	Group 1–3:4–54:12
				UH	64	75	82.8		56:8
3	Taylor et al. [9]	2012	RCT	CH	80	71.3	85.3	24	Mean ASA-2.95
				UH	80	66.2	85.1		2.99
4	Langslet et al. [16]	2013	RCT	CH	112	78	83.4	60	Group 1, 2: 42%
				UH	108	74	83		44%
5	Moerman et al. [17]	2017	RCT	CH	110	75	83	12	ASA 1:6, ASA 2: 71, ASA 3: 33
				UH	91	67	84		ASA 1:7, ASA 2: 51, ASA 3: 33
6	Mohabey et al. [18]	2017	RCT	CH	20	55	70	6	NA
				UH	20				NA

RCT, randomised controlled trial; CH/UH, cemented/uncemented hemiarthroplasty; NA, not available; ASA, American Society of Anaesthesiologists

Table 3 Reported outcomes in the studies

Study	Groups (1—CH, 2—UH) groups (1—CH, 2—UH)	Perioperative data (mean surgical time, estimated blood loss)	Post-operative data (ambulation time, hospital stay days, rates of complications like shortening, infections, delayed and non unions)	Incidence of fractures, loss of reduction/fixation or D/L or stem loosening	No. of re-operation	Mortality	QOL score (BI-Barthel index, EuroQoL-EQ-5D), SF-12, HRQoL; functional outcome score (HHS), SMFA, PADI/IADL, TUG score, Oxford score	Visual analogue scale/pain medication	Authors' conclusions
Figved et al. [14]	CH	82.6 min, 390 ml	Stay: 7.8	1 Periprosthetic fracture	7	19% at 1 year	BI of 19/20; 45 patients; EQ-5D: 0.68	No pain medication in 68 patients	No overall difference between both techniques as long as the selected implants are advanced.
	UH	70.2 min, 300 ml	Stay: 8.4	1 Trochanter fracture, 1 fracture distal to tip of stem	8	29%	48;0.61	63 patients	
DeAngelis et al. [15]	CH	108.2 min 257 ml	Complications: 16.7%	Intra-operative fractures: 3%	0	23.1%	PADI: 4.4; IADL: 3.1	NA	Similar outcomes in both groups
	UH	103.6 min 279 ml	18.8	4.7%	1	20%	5.7;3.4	NA	
Taylor et al. [9]	CH	79.3 min 254 ml	Stay: 27.2; Infections: 5%;	Subsidence: 1 case; postop fracture: 1 case; dislocation: 2 cases	2	43.8% at 2 years	Oxford score: 35.5 at 6 weeks; TUG test faster ($p < 0.05$) at 6 months and 1 year	NA	Outcomes are similar in both groups; however, incidence of subsidence and fractures is more in uncemented group
	UH	74.7 min 251 ml	26.5; 6%	18 Cases; 12 cases had intra-operative fractures: ($p < 0.05$)	4	40%	38.8 at 6 weeks ($p < 0.05$); TUG slower	NA	
Langslet et al. [16]	CH	82.6 min 390 ml	Stay: 7.8	1 Periprosthetic fracture	7	56% at 5 years	HHS: 76.3(5 years); BI of 19/20 in 25 patients; EQ-5D score: 0.64	No pain medication required in 31 patients	Uncemented hemiarthroplasty is associated with more periprosthetic loosening and fractures, so cemented is favourable

Table 3 (continued)

Study	Groups (1—CH, 2—UH) groups (1—CH, 2—UH)	Perioperative data (mean surgical time, estimated blood loss)	Post-operative data (ambulation time, hospital stay days, rates of complications like shortening, infections, delayed and non unions)	Incidence of fractures, loss of reduction/fixation or D/L or stem loosening	No. of re-operation	Mortality	QOL score (BI-Barthel index, EuroQol-EQ-5D), SF-12, HRQoI; functional outcome score (HHS), SMFA, PADL/IADL, TUG score, Oxford score	Visual analogue scale/pain medication	Authors' conclusions
	UH	70.2 min 300 ml	Stay: 8.4	1 Trochanter fracture, 1 fracture distal to tip of stem	11	60%	86.2 ($p=0.027$); 26 patients; 0.73	28 patients	
Moerman et al. [17]	CH	55.4 min	Stay: 11; Infections: 7	Periprosthetic fractures: 3; dislocations: 3; loosening: 5	1	19% at 1 year	Mean TUG: 13.9; SF-12 (physical): 38.5 (12 weeks, $p=0.018$)	NA	More complications like loosening, subsidence, re-operations and inferior quality of life scores are seen in UH, so CH should be favoured.
	UH	57.3 min	Stay: 11; infections: 3	14; 5 ($p=0.05$); 14 ($p=0.007$)	3	27%	12.8; 33.8	NA	
Mohabey et al. [18]	CH	111.5 min; 310.5 ml	NA	NA	NA	1 death	HHS: excellent—15.79%, good—52.63%, fair—26.32%, poor—5.26%	No difference in pain between groups	Similar outcomes in both groups
	UH	78.25 min; 176 ml	NA	NA	NA	NA	20%, 70%, 10%, 0		

CH/UH, cemented/uncemented hemiarthroplasty; D/L, dislocation; HHS, Harris hip score; QoL, quality of life; TUG, timed up and go; SMFA, short musculoskeletal functional assessment; BI, Barthel index; PADL/IADL, activities of daily living

generation, allocation concealment, blinding of outcome assessments, incomplete outcome data, selective reporting and other biases were assessed.

Evidence grading

Quality of evidences for the outcomes were graded using GRADE system (Grading of Recommendations Assessment, Development and Evaluation). Level of evidence strength was classified as high: Further research is very unlikely to change the confidence in the estimate of effect, moderate: Further research is very likely to have an important impact on the confidence in the estimate of effect, may change the effect, low: Further research is very likely to have an important impact on the confidence in the estimate of effect, likely to change the effect and very low: Very uncertain about the estimate. We assessed strength of evidence with the “Grade system pro” and summarised the results (Table 4). Results showed that post-operative hip function, residual pain and intra-operative blood loss showed low strength. Prosthesis complications, general complications and mean surgical time showed moderate strength. Local complications, mortality at 1 year and re-operation rate showed high strength.

Statistical analysis

We analysed our data with Review Manager Software (RevMan 5.3). For dichotomous data, odds ratio (OR) and 95% confidence intervals (CI) were calculated. For continuous data, weighted mean difference (WMD) and 95% CI were calculated. We used fixed effects model to estimate overall effect sizes. I^2 value and chi-square test were used to assess statistical heterogeneity. p value > 0.1 and I^2 value of $> 50\%$ were considered as statistical heterogeneity. Sensitivity analysis was carried out to check whether a particular study has larger impact on outcome.

Identification of studies

A total of 2696 studies were identified by the word search on all three databases. These studies have been published between the year 2008 and 2017. After assessing the titles for comparative evaluation of both the techniques, 121 studies were identified. Abstracts were read of all these studies and finally after excluding the repetitive or duplicate studies 18 studies were further identified and full texts were read, out of which 6 studies were included in the review [9, 14–18] (Fig. 1). Langslet et al. further followed the same patients from the study of Figved et al., so we did not include their study in the meta-analysis [14, 16].

Risk of bias

Risk of bias of the studies we included was low. Randomisation technique like computer-generated number was mentioned in three studies [14, 15, 17]. Allocation concealment was mentioned in two studies [14, 15]. Outcome assessors were blinded in three studies [9, 15, 17]. Risk of bias about methodological quality of the included studies is shown in Figs. 2 and 3.

Study characteristics

All six studies included are randomised controlled trials directly comparing cemented and uncemented hemiarthroplasties. All of them were published in last 10 years. The minimum number of patients included is 20 in each group [18]. The maximum number of patients in a study is 220 [14, 16]. Different uncemented designs have been compared with standard cemented stems by individual studies and offer clearance on the pros and cons of both. The studies have mentioned comparability of individual groups in terms of preoperative parameters like age, sex and ASA scores.

Demographic variables

Age

All the included studies have mean age of the patients above 65 years. This is the age group, where arthroplasty is recommended for fractures of NOF, in view of osteoporosis and poor bone stock. All the studies note that the average age as a factor was comparable between both the groups and no age bias was present. The majority of patients were above 80 years of age, where in the osteoporosis incidence is very high and the role of uncemented stems in patients of this age group is unclear, because of wide medullary canals and thinned out cortices.

Sex

All the 6 studies have shown that the NOF is more prevalent in the females as compared to their male counterparts. Postmenopausal osteoporosis secondary to hormonal imbalance is a major determinant of decreased quality of bones in the females [19]. Both the groups in all the studies were comparable without any gender bias with proportional male-to-female ratio between the groups, with females being in majority.

ASA scores

None of the studies showed any significant difference in preoperative ASA scores between the two groups that could eventually be a factor governing morbidity and mortality intra-operatively and post-operatively. Five studies

Table 4 Assessment of strength of evidence

No. of studies	Certainty assessment				No. of patients		Effect		Certainty	Importance		
	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Cemented hemiarthroplasty	Uncemented hemiarthroplasty			Relative (95% CI)	Absolute (95% CI)
Post-operative hip function at 1 year (follow-up: 1; assessed with: requirement of assistance with ambulation)												
4	Randomised trials	Not serious	Not serious	Not serious	Very serious ^{a,b}	None	87/292 (29.8%)	120/275 (43.6%)	OR 0.45 (0.29 to 0.67)	178 Fewer per 1000 (from 95 fewer to 253 fewer)	⊕⊕○○ Low	Critical
3	Randomised trials	Not serious	Serious ^c	Not serious	Serious ^{d,e}	None	41/196 (20.9%)	35/161 (21.7%)	OR 0.89 (0.53 to 1.51)	19 Fewer per 1000 (from 78 more to 89 fewer)	⊕⊕○○ Low	Critical
Prosthesis complications (follow-up: range 1 to 2 year)												
4	Randomised trials	Not serious	Not serious	Not serious	Serious ^{d,f}	None	20/368 (5.4%)	69/343 (20.1%)	OR 0.24 (0.14 to 0.41)	144 Fewer per 1000 (from 108 fewer to 167 fewer)	⊕⊕⊕⊕ Moderate	Critical
Local complications (follow-up: range 1 to 2 years)												
4	Randomised trials	Not serious	Not serious	Not serious	Not serious	None	28/368 (7.6%)	19/343 (5.5%)	OR 1.30 (0.69 to 2.45)	15 More per 1000 (from 17 fewer to 70 more)	⊕⊕⊕⊕ High	Critical
General complications (follow-up: range 1 to 2 years)												
4	Randomised trials	Not serious	Not serious	Not serious	Serious ^{d,f}	None	43/368 (11.7%)	101/343 (29.4%)	OR 0.26 (0.16 to 0.41)	197 Fewer per 1000 (from 148 fewer to 232 fewer)	⊕⊕⊕⊕ Moderate	Critical
Mortality after 1 year (follow-up: range 1 to 2 years)												
4	Randomised trials	Not serious	Not serious	Not serious	Not serious	None	85/319 (26.6%)	65/340 (19.1%)	OR 1.61 (1.10 to 2.36)	84 More per 1000 (from 15 more to 167 more)	⊕⊕⊕⊕ High	Critical
Re-operation (follow-up: range 1 to 2 years)												
4	Randomised trials	Not serious	Not serious	Not serious	Not serious	None	15/368 (4.1%)	17/343 (5.0%)	OR 0.85 (0.41 to 1.76)	7 Fewer per 1000 (from 29 fewer to 35 more)	⊕⊕⊕⊕ High	Important

Table 4 (continued)

No. of studies	Certainty assessment				No. of patients		Effect		Certainty	Importance		
	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Cemented hemiarthroplasty	Uncemented hemiarthroplasty			Relative (95% CI)	Absolute (95% CI)
Mean surgical time (follow-up: range 1 to 2 years)												
4	Randomised trials	Not serious	Not serious	Not serious	Serious ^{d,f}	None	368	343	–	MD 6.4 higher (3.4 higher to 9.41 higher)	⊕⊕⊕○ Moderate	Not important
Intra-operative blood loss (follow-up: range 1 to 2 years)												
4	Randomised trials	Not serious	Serious ^a	Not serious	Serious ^{d,f}	None	367	343	–	MD 5.89 higher (18.88 lower to 30.65 higher)	⊕⊕○○ Low	Not important

CI, confidence interval; OR, odds ratio; MD, mean difference

^aNo. of hips analysed were low in number, so imprecision downgraded by a level

^bCriteria used for assessing post-operative hip functions in different trials were different

^cCriteria used for assessing post-operative in different trials were different

^dDue to high heterogeneity (I2 value > 50)

^eSensitivity analysis of residual pain showed I2 value 0% favouring cemented group

^fNo difference in I2 values even after sensitivity analysis

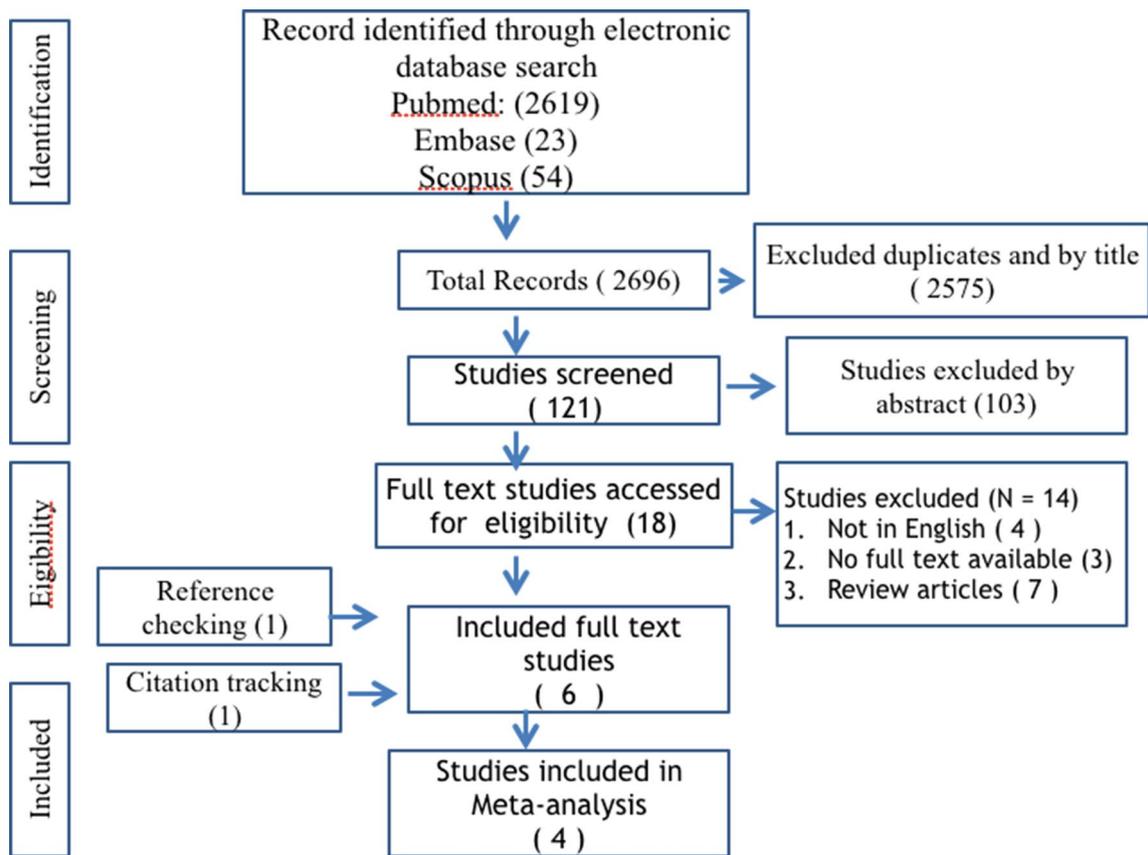


Fig. 1 Flowchart depicting selection of articles

assessed the ASA grades in all their patients. Mohabey et al. [18] have not commented on the preoperative ASA grades.

Implants used

Five studies have mentioned the type of uncemented and cemented stems they have used and compared. Two studies have compared Spectron stem from Smith and Nephew with the Corail system from Depuy [14, 16]. The set of patients followed were the same in these studies. Bipolar heads were used. DeAngelis et al. [15] used both stems (Versys) from Zimmer, Warsaw with a unipolar head. Taylor et al. [9] used a cemented modular Exeter stem from Stryker and an uncemented Alloclassic stem from Zimmer. UniTrax head from stryker was used. Moerman et al. [17] have used both implants from Zimmer-Biomet (Muller: cemented, DB-10: uncemented). All the uncemented stems used in these studies are the most modern advanced systems with hydroxyapatite coatings or grooves or beaded coats or are grit blasted. These have been shown to have good outcomes in treating fractures of neck of femur.

Results of meta-analysis

Primary outcomes

Post-operative hip function

Different studies used different scoring systems like Harris hip score, TUG test, SF-12 etc., to measure post-operative hip function. Three studies did not find any difference in the functional outcomes and quality of life scores, analgesic requirements and ambulation status in both the groups [9, 14, 15]. TUG test or the Timed Up and Go test (TUG) is a simple test used to assess a person's mobility and requires both static and dynamic balance. It uses the time that a person takes to rise from a chair, walk three metres, turn around, walk back to the chair and sit down [20].

In the study by Moerman et al., there was no difference in the TUG scores between both groups. The health-related quality of life scores, mobility scores, the mental state examination and the activity restriction scale (GARS) were all similar in both groups. The physical component of SF-12 score was lower in the uncemented group initially; however, it became comparable in both the groups at 1 year of

	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
De Angelis 2012	?	?	+	+	+	+
figved 2009	+	+	+	+	+	+
Moerman 2017	+	+	+	+	+	+
Taylor 2012	+	+	+	+	+	+

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

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

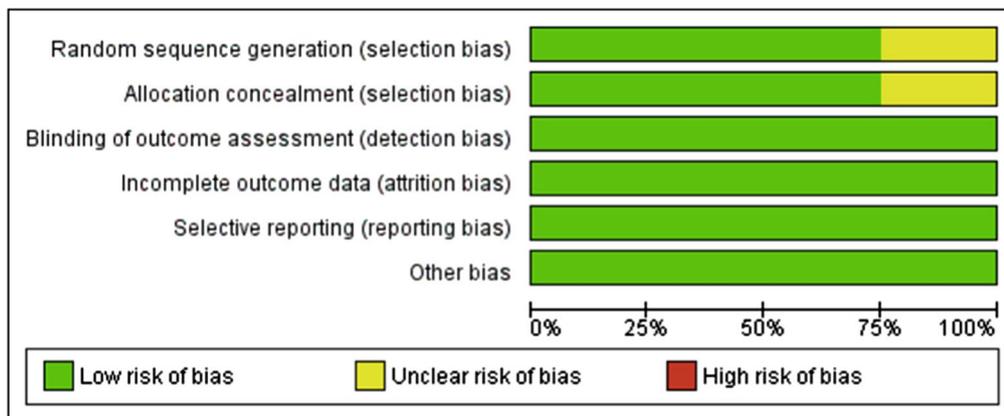
follow-up. Mohabey et al. [18] did not find any difference in ability to walk with aids, pain scale and HHS at 6 weeks of follow-up.

HHS was better at 5 years of follow-up in the study by Langslet et al. [16] in the uncemented group. However, the other scores of EQ-5D and Barthel index were not different. The authors raise doubt regarding their own finding in view of many deaths in both the groups and crossover deviations. Even the analgesic requirement and ambulation status did not differ.

In view of such a variety of scoring tools, we were unable to compare them but used a parameter which was comparable in four studies—patients requiring assistance in ambulation [9, 14, 15, 17]. At 1 year, there was a significant difference between 2 groups with odds ratio 0.45 (95% CI 0.29–0.67, $p=0.0001$) favouring cemented group. In the 4 studies, only 87 out of 292 patients required assistance in ambulation in cemented group, and 120 out of 275 required assistance in ambulation. After 1 year, a better functional outcome was seen in cemented hemiarthroplasty group (Fig. 4).

Residual pain

Three studies reported on residual pain with I^2 value 48%, OR 0.89 (95% CI 0.53–1.12, $p=0.68$) on meta-analysis [9, 14, 17]. Though the outcome was not much different in two groups, 41 out of 196 patients had residual pain in cemented group and 35 out of 161 patients in uncemented group had residual pain, further sensitivity analysis showed low heterogeneity I^2 value 0%, favouring cemented group ($p=1.0$) (Fig. 5).



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

Fig. 3 Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies

Complications

The reported complications are subsidence, fractures, infections and dislocations. Earlier Cochrane reviews have not found any difference between the two groups in these variables [5]. Figved et al. [14], Mohabey et al. [15] and DeAngelis et al. [18] did not find any significant differences. However, Taylor et al. [9] reported increased intra- and post-operative fractures and subsidence in the uncemented group ($p < 0.05$). Langslet et al. [16] also confirmed more fractures in the uncemented group at 5 years of follow-up and concluded that this is the single most important factor that signifies superiority of CH over UH in elderly patients with NOF fractures. Similar results were shown by Moerman et al. for uncemented group with more number of periprosthetic

fractures and dislocations. They even reported more subsidence and loosening in the second group [17].

We categorised the complications as prosthetic-related (fracture, dislocation and subsidence), local complications (haematoma, discharge or infection) and general complications (pneumonia, DVT etc.). Prosthetic-related complications were higher in the uncemented group, analysis favouring cemented group; odds ratio 0.24 (95% CI 0.69–2.45, $p < 0.00001$) (Fig. 6). Although local complications were higher in cemented group, it was not significantly different, odds ratio 1.30 (95% CI 0.68–2.45) (Fig. 7). General complications were less in cemented group with low heterogeneity (p value < 0.00001) and odds ratio 0.26 (95% CI 0.16–0.41). But the data for general complications showed high heterogeneity. On doing sensitivity analysis for general

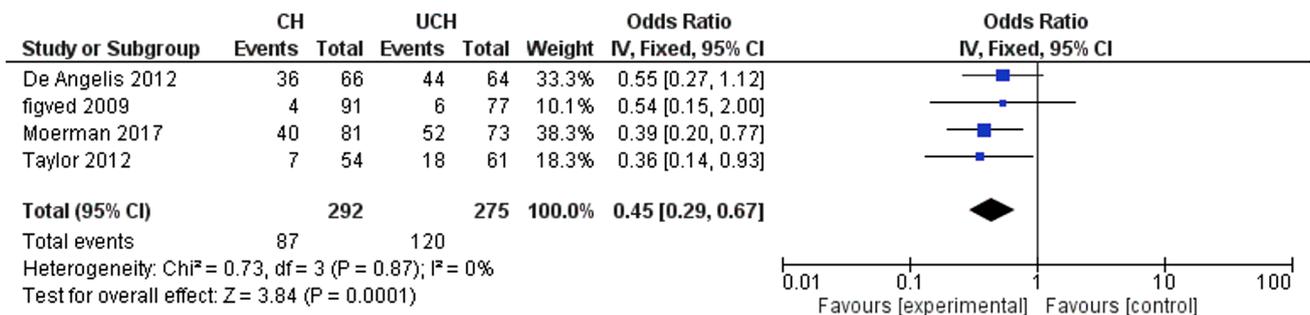
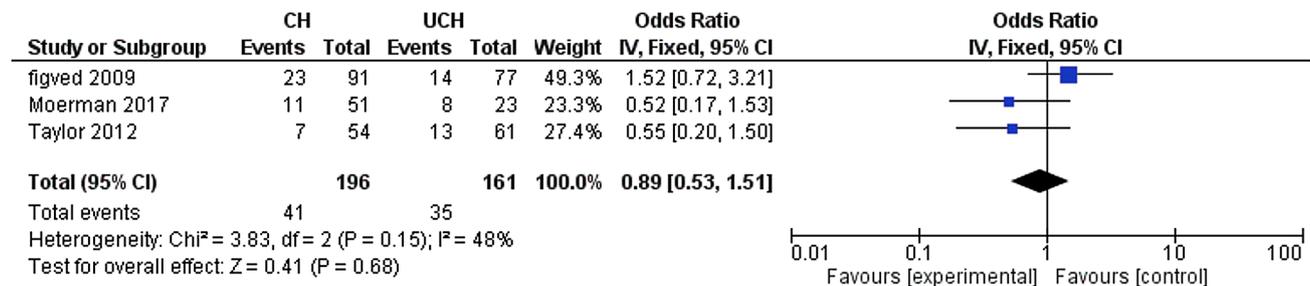


Fig. 4 Meta-analysis for post-operative hip function (Experimental = CH; Control = UH)



Sensitivity analysis of residual pain

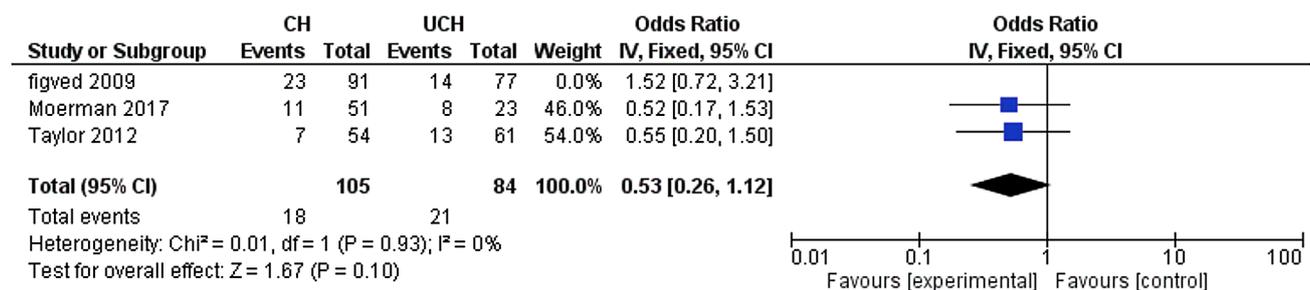


Fig. 5 Meta-analysis for residual pain (Experimental = CH; Control = UH)

complications, it favoured cemented group and I^2 value was 0% (Fig. 8).

Mortality

There were no difference in rates of mortality till 2 years of follow-up in study by Figved et al. When Langslet et al. [16] followed these patients at 5 years, more than 50% of patients in both the group expired. However, there was no statistically significant difference between the groups. DeAngelis et al. also reported no difference between the groups with 23.1 and 20% deaths at 1 year of follow-up. No difference was reported by Taylor et al. [9] and

Moerman et al. [17] as well. The latter reported more number of deaths in uncemented group but this was not statistically significant. Mohabey et al. [18] only reported 1 death in their study, but it is a short-term study with only 6 months of follow-up.

We meta-analysed four studies that reported mortality at 1 year [9, 14, 15, 17]. In cemented group, there were 85 deaths out of 319 and in uncemented group there were 65 deaths out of 340. Analysis favoured uncemented group, odds ratio 1.61 (95% CI 1.10–2.36 and $p=0.01$) (Fig. 9). The reason for this difference may not be the surgery itself. Although the studies were RCTs, intra-operatively the plan could have been changed depending

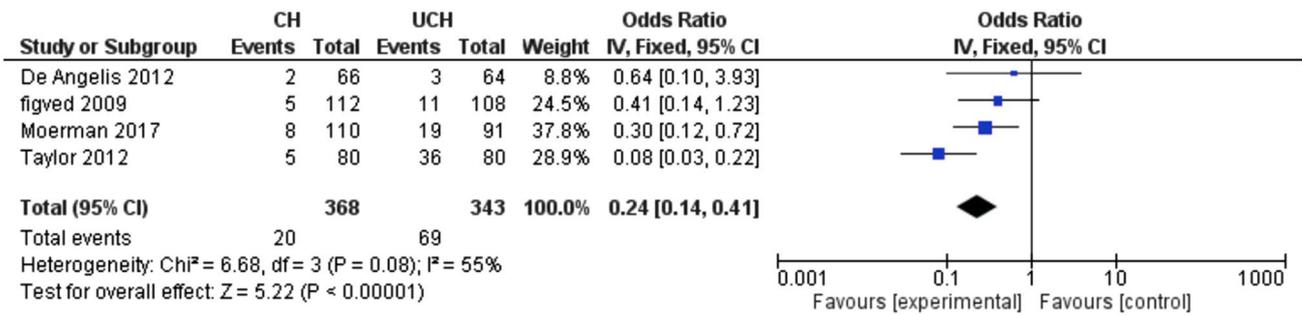


Fig. 6 Comparison of prosthetic-related complications (Experimental = CH; Control = UH)

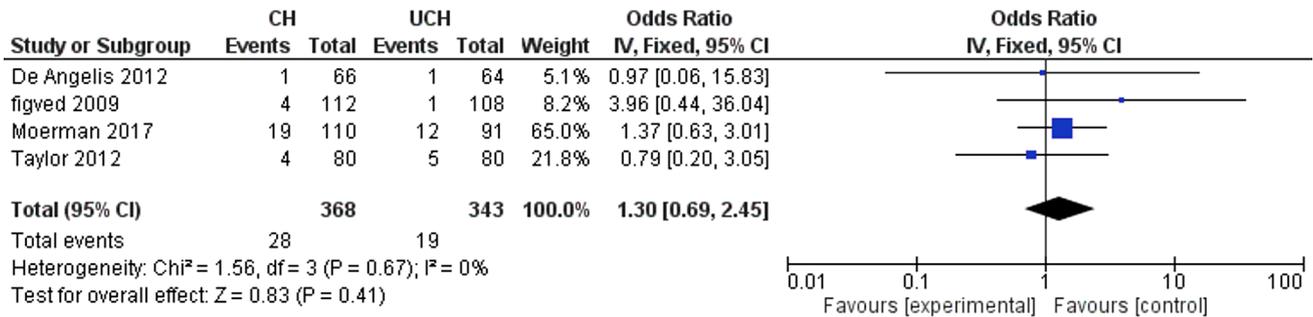


Fig. 7 Meta-analysis for local complications (Experimental = CH; Control = UH)

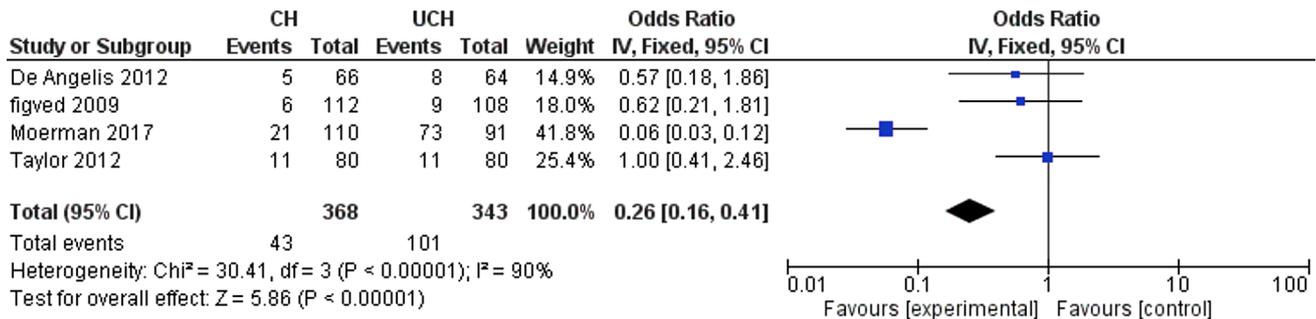


Fig. 8 Meta-analysis for general complications (Experimental = CH; Control = UH)

upon the quality of bone and size of medullary canal and the patient continued to be in the assigned group with the principle of “intention to treat”. However, such patients are generally physiologically older with associated comorbidities and hence their rates of mortality could be influenced due to this bias. So 1-year mortality after all may not be such a big consideration to avoid cemented surgeries and prefer uncemented ones.

Secondary outcomes

Re-operation rate

The rates did not differ significantly between the groups in any of the studies, despite higher incidence of implant loosening, fractures and subsidence in the uncemented group in several studies [9, 16, 17]. In cemented group, there were 15 re-operations out of 368 and in uncemented group there were 17 re-operations out of 343. Our analysis favoured cemented group [Odds ratio 0.85 (95% CI 0.41–1.76)] (Fig. 10).

Mean surgical time

Meta-analysis favoured uncemented group where the surgeries were significantly faster, mean difference 6.40 (95% CI 3.40–9.41) (Fig. 11).

Mean operative blood loss

4 studies in the meta-analysis mentioned about operative blood loss and relied on surgeon’s assessment for the amount of loss. Our analysis favoured uncemented group, but there was statistical heterogeneity ($I^2 = 86\%$). So we further did sensitivity analysis and got I^2 value of 56%, still indicating high heterogeneity. The mean surgical blood loss was high in cemented group, but due to the heterogenous data, conclusive evidence could not be achieved (Fig. 12).

Discussion

Proximal femur fractures are major healthcare issue in the elderly. Owing to the widespread prevalence of osteoporosis in this age group, fractures of the neck of femur and the intertrochanteric femur are increasing in incidence, with trivial trauma due to fall being the major mechanism of injury. These injuries are associated with plethora of complications in the geriatric population. Prolonged bed rest caused by these injuries due to inability of the patients to bear weight leads to serious cardiopulmonary deficits, bed sores, thromboembolic events and stroke, etc. [3].

These patients require early interventions so that they can be brought out of their beds, so as to diminish these

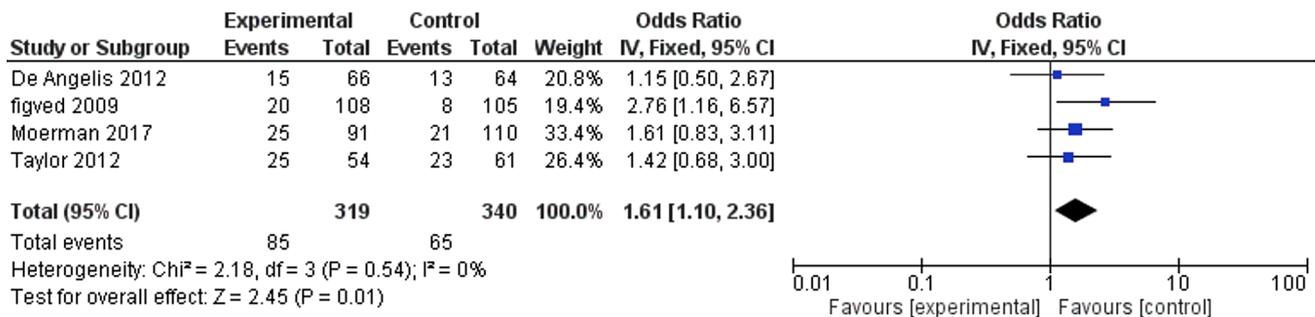


Fig. 9 Difference in mortality at 1 year (Experimental=CH; Control=UH)

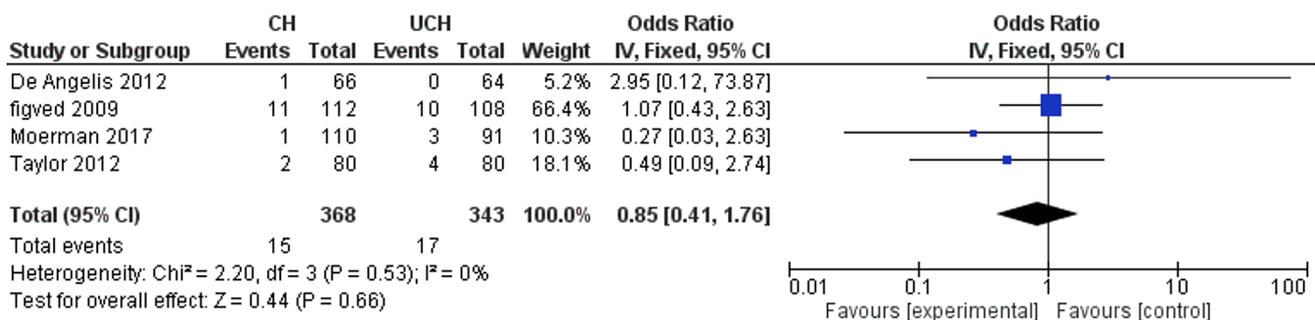


Fig. 10 Meta-analysis for re-operation rates (Experimental=CH; Control=UH)

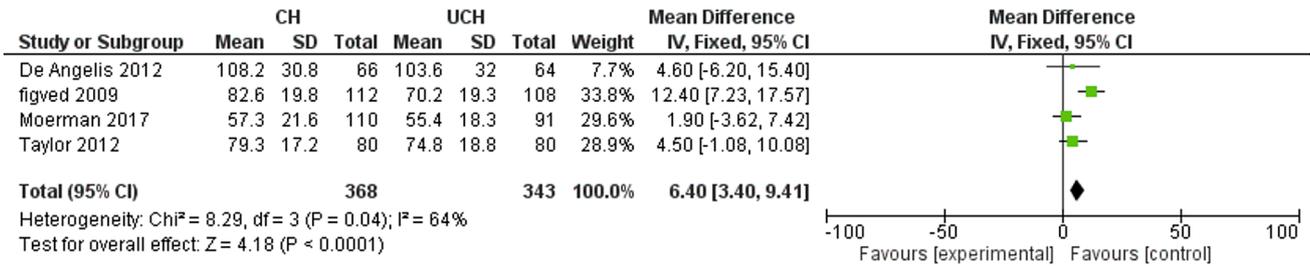


Fig. 11 Difference in surgical duration (Experimental = CH; Control = UH)

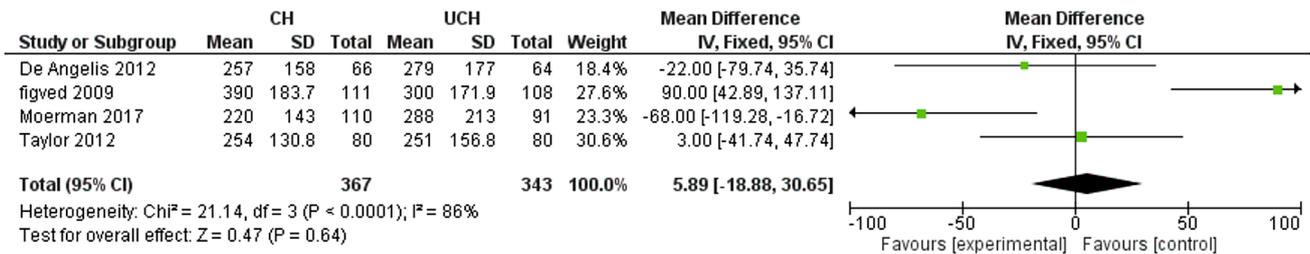
complications. Hemiarthroplasty is one such surgical technique that provides excellent results for these subsets of trauma patients. Ever since its inception, the technique and implants have improved, so as to increase the efficacy of the surgery and provide the geriatric patients with early recovery and apt functional outcomes. The controversy lies in the question, whether to cement or not, and can uncemented techniques offer the same results as the cemented methods, in the terms of complications, morbidity, mortality, functional outcomes and quality of life that these patients can achieve? We conducted this systematic review and meta-analysis, wherein we assessed the most recent evidence to answer these questions. Earlier Cochrane reviews and meta-analysis have not found any significant differences between the two surgical techniques of hemiarthroplasties, except for decreased pain and improved mobility in cemented cases [5, 10, 11]. But these are all old studies with majority of stems used being the primitive Thompson or Moore’s prosthesis. We specifically looked into the literature of last 10 years so

that the ever evolving technologies in arthroplasties could be taken into consideration and we could update the evidence with our meta-analysis.

Our meta-analysis shows that cemented techniques provide the patients with better functional outcomes and lesser residual pain after 1 year of surgery. Additionally, uncemented surgeries have relatively more, implant-related complications like subsidence and fractures.

Due to multiple scoring methods and variables, we could not include all the studies in the meta-analysis, e.g. for the functional outcomes, we could not comment on any scoring method, but used ambulation at 1 year as the only measure, where cemented method is superior. In view of this limitation, we cannot effectively and objectively compare this important outcome, but only have a subjective evidence.

The cemented group has better ambulation and lesser pain in our meta-analysis. Since the uncemented stems work on principle of press fit, incidence of fractures during insertion or broaching is commonly encountered. Also lack of optimal



Sensitivity analysis of blood loss

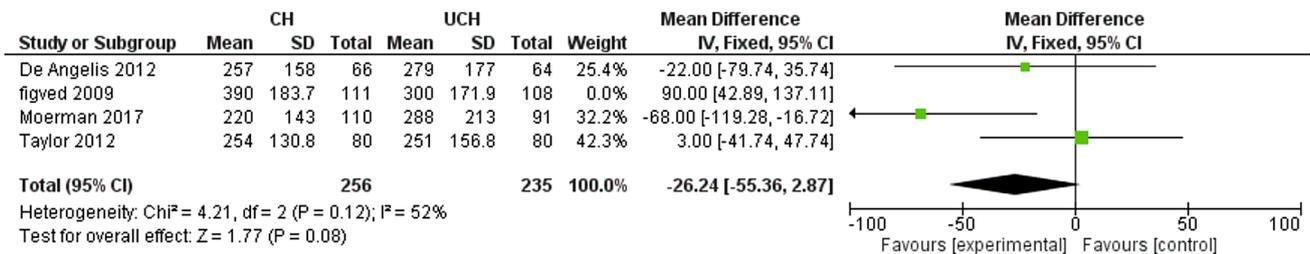


Fig. 12 Meta-analysis for intra-operative blood loss (Experimental = CH; Control = UH)

incorporation in view of poor bone quality in elderly eventually leads to subsidence and failure. These complications have been found to be significant in our study. These can further be the reason for increased pain and inferior ambulation in uncemented cases. This may lead to a vicious cycle of worse results. Therefore, we recommend careful surgical steps in uncemented surgeries, without usage of major force. The bone quality should be carefully assessed to minimise risks of subsidence and fractures.

There is no significant difference between the groups in the incidence of local complications, while significantly lesser systemic complications like pneumonia and venous thromboembolism occurred in the cemented group. The probable reason for more cases of DVT in uncemented group could be the fact that mobilisation is often delayed in them, while cemented cases are mobilised earlier. However, increasing number of surgeons are mobilising the uncemented cases early nowadays that may help in decreasing pulmonary and vascular complications.

In terms of mortality at 1 year, the results were contrary. This was significantly more in cemented patients and gives value to the usage of uncemented stems in the elderly to minimise fatal complications. However, the reason may not be the surgery itself, but overall inferior physiology of cemented group in terms of wider canal, greater age and co-morbidities. In terms of other secondary outcomes, there was no difference between the groups.

The present meta-analysis encompasses all the variables that assess both the techniques of hemiarthroplasties, by studying randomised controlled trials that give strong level 1 or 2 evidence. We have included the most recent RCTs and determined the supremacy of cemented over uncemented hemiarthroplasties. The newer uncemented stems are faster surgeries with lesser duration but have more incidence of implant-related complications like loosening, subsidence and fractures despite the ever evolving designs and materials. Newer stems are warranted that could provide better incorporation and stability especially in patients with wider canals and poor bone quality.

Conclusion

The complications related with uncemented hemiarthroplasties are substantially more than cemented ones. Additionally cemented methods provide better ambulation and pain relief which strongly favour usage of cement in hemiarthroplasties in elderly patients of neck of femur fractures. Therefore, cementing techniques are here to stay, until a better, durable and more stable uncemented stem evolves that could lessen these complications and match the cemented implants.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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