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Systematic Review and Meta-analysis

Does total hip arthroplasty provide better outcomes than hemiarthroplasty for the femoral neck fracture? A systematic review and meta-analysis

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ABSTRACT

Purpose: By comparing the outcomes of total hip arthroplasty with hemiarthroplasty in elderly patients with a femoral neck fracture to investigate the one-year mortality, dislocation, infection, reoperation rate, and thromboembolic event.

Methods: The PubMed, EMBASE databases, and Cochrane library were systematically searched from the inception dates to April 1, 2020 for relevant randomized controlled trials in English language using the keywords: "total hip arthroplasty", "hemiarthroplasty" and "femoral neck fracture" to identify systematic reviews and meta-analyses. Two reviewers independently selected articles, extracted data, assessed the quality evidence and risk bias of included trials using the Cochrane Collaboration' stools, and discussed any disagreements. The third reviewer was consulted for any doubts or uncertainty. We derived risk ratios and 95% confidence intervals. Mortality was defined as the primary outcome. Secondary outcomes were other complications, dislocation, infection, reoperation rate, and thromboembolic event.

Results: This meta-analysis included 10 studies with 1419 patients, which indicated that there were no significant differences between hemiarthroplasty and total hip arthroplasty in reoperation, infection rate, and thromboembolic event. However, there was a lower mortality and dislocation rate association with total hip arthroplasty at the one-year follow-up.

Conclusion: Based on our results, we found that total hip arthroplasty was better than hemiarthroplasty for a hip fracture at one-year follow-up.

Introduction

The person-based incidence of femoral neck fractures in adults was 1.6 million globally every year,[1] which is expected to increase to over 6 million worldwide by the year 2050.[2–5] The risk of femoral neck fracture increases with age, especially for those with over 60 years old. A femoral neck fracture can result in non-union or avascular necrosis, which is among the top 10 causes of disability and death in adults.[6]

Two major surgical options for femoral neck fractures are total hip arthroplasty and hemiarthroplasty. Which treatment is the better choice for femoral neck fracture has been controversial for many years.[6] Many surgeons are convinced that femoral neck fracture should be treated by total hip arthroplasty for better outcomes.[7,8] There still has been some uncertainty about the effect of total hip arthroplasty for femoral neck fracture compared with hemiarthroplasty. Other surgeons believe that hemiarthroplasty is the best method of treatment for a fracture of the femoral neck, with the advantages of reduced dislocation rate, less infection chance, lower reoperation rate, and fewer thromboembolic event.[9]

Therefore, the primary purpose of this study is to compare the mortality, dislocation, infection, and reoperation rate and the thromboembolic event of total hip arthroplasty *vs.* hemiarthroplasty in elderly patients with a femoral neck fracture. We suppose that this study will provide more useful evidence for clinical decisions.

Methods

Protocol and guidance

This meta-analysis trial was registered on PROSPERO net under registration number (CRD 42020176350). This study follows the

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recommendations of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist and flowchart.

Search trials

We searched the PubMed, EMBASE databases, Cochrane library from inception to April 1, 2020, for relevant RCTs with English language restrictions. Keywords used for searching were total hip arthroplasty, hemiarthroplasty, and femoral neck fracture.

Study eligibility criteria

Inclusion criteria were: (1) the data published in English language literature; (2) the study involving femoral neck fractures, designed as RCTs and compared total hip arthroplasty with hemiarthroplasty; (3) the study population was aged at least 60 years old. Exclusion criteria were: letters, comments, editorials, case reports, non-English language publications, and nonrandomized trials.

Data extraction and outcomes

After the removal of duplicates, all relevant information was independently screened from publications that were selected by two investigators (Peng W and Xi N). Disagreements were resolved by discussion. Where there was uncertainty, the third investigator was consulted (Zheng J) for any uncertainties. The primary outcome was mortality and secondary outcome was dislocation, infection, reoperation rate, and thromboembolic event. The follow-up period was one year.

Assessment of risk bias and quality evidence

The risk of bias and methodological quality was assessed using the Cochrane Collaboration risk of bias tool to determine whether bias might have affected the results. Results of the study were evaluated to be of high risk, unclear or low risk.

Assessment of heterogeneity and sensitivity analysis

Forest plots were used to present the results of the individual studies and respective pooled estimates of effects size. Heterogeneity of studies was tested using the Chi-squared statistic and was considered significant if $p < 0.01$. If heterogeneity was found to be significant, a random-effect was used. If heterogeneity was found to be no significant, a fixed-effects model was used. The funnel plots model was used to assess bias for any outcomes. All statistical analyses were using Revman software, version 5.3. (The Nordic Cochrane Centre, The Cochrane Collaboration, 2014; Copenhagen, Denmark). We use risk ratio and their associated 95% confidence intervals to assess results and considered a p value less than 0.05 to be statistically significant.

Results

Search results

The search strategy identified 1548 relevant studies (Fig. 1). Following the screening and application of eligibility criteria, we were able to select ten studies of their full texts for inclusion criteria (Table 1). Of 1419 screened patients from the year 2006–2019, 671 were randomly allocated to receive a total hip arthroplasty and 748 to receive a hemiarthroplasty.

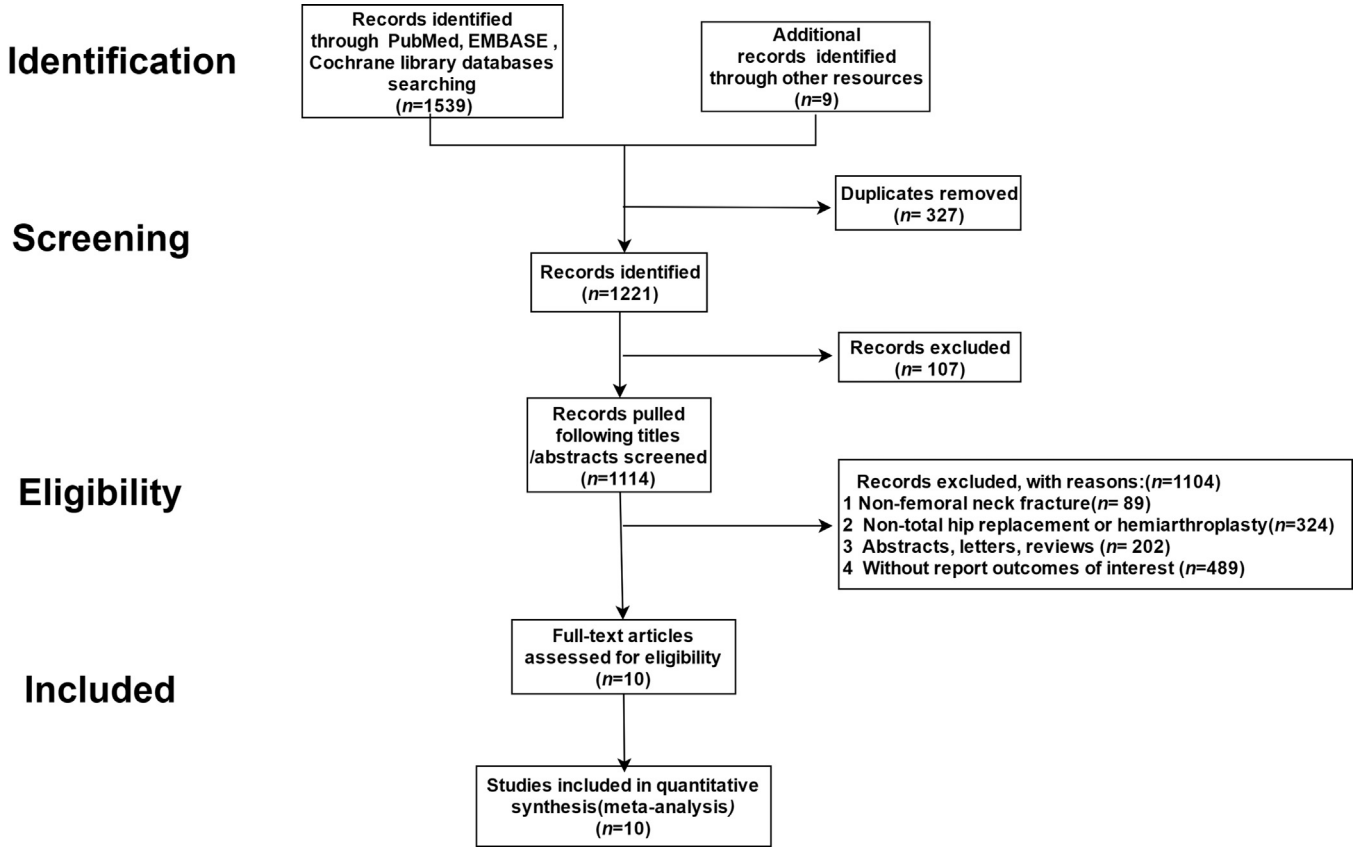

Fig. 1. Flow diagram outlining searching and screening process.

Table 1
Characteristic of included studies.

First author	Year	Patient (*n*)		Mean age (year)	Women (%)		Mean follow-up (year)
		THA	HA		THA	HA	
Baker RP[7]	2006	40	41	HA 75.8 (66.0–86.0); THA 74.2 (63.0–86.0)	80.0	78.1	1.0–3.0
Bensen AS[8]	2014	175	171	HA 84.1; THA 75.2	Unclear	Unclear	2.1
Boukebous B[9]	2018	98	101	80.6 (76.0–101.0)	72.0	72.0	24.2
Cadossi M[10]	2013	42	41	THA 82.3 (71–96); HA 84.2 (73–98)	81.0	68.0	1.0–3.0
Fahad S[11]	2019	27	77	THA 69.3 ± 9.0; HA 71.1 ± 10.9	51.9	59.7	1.0
Giannini S[12]	2011	30	30	THA 80.7 (65–89); HA 82.6 (68–92)	Unclear	Unclear	1.0
Kim YT[13]	2017	84	84	THA 73.1 ± 6.0; HA 72.9 ± 7.8	69.0	67.9	2.0
Macaulay W[14]	2008	17	23	THA 82.0 ± 7.0; HA 77.0 ± 9.0	41.0	61.0	2.0
Mouzopoulos G[15]	2008	37	34	THA 73.1 ± 4.9; HA 74.2 ± 3.8	75.6	70.5	4.0
Tol MC[16]	2017	115	137	Over 60.0	78.0	84.0	12.0

THA = total hip arthroplasty, HA = hemiarthroplasty.

Baseline characteristics

Table 1 shows the baseline characteristics of the 1419 participants in detail.

Methodological quality assessment

Fig. 2 shows the assessment results of the risk of bias in selected studies. The most unclear risk or high risk of bias came from performance bias and detection bias because of inadequate blind assessment and outcome assessors.

Primary outcome

One-year mortality

Ten studies[7,8,10–17] reported mortality rate at one year after operation, which included a total of 1419 patients. The pooled were performed by using a fixed-effect model for no heterogeneity ($I^2 = 0\%$, $p = 0.49$). The result showed a significant difference between the two groups ($RR = 0.75$, 95% $CI = 0.58$ to 0.98, $p = 0.03$, Fig. 3).

Secondary outcome

Dislocation rate

Of the ten studies, five[7,8,10,11,15] reported dislocation rate. A fixed-effect model was applied because no heterogeneity existed among the trials ($I^2 = 38\%$, $p = 0.17$). The pooled data showed a significant difference in dislocation rate between total hip arthroplasty and hemiarthroplasty ($RR = 0.46$, 95% $CI = 0.27–0.79$, $p = 0.005$, Fig. 4).

Infection rate

Four studies,[7,8,11,13] in which a total of 412 patients were evaluated, reported infection rate. A fixed-effected model of analysis was used due to heterogeneity among the studies ($I^2 = 0\%$, $p = 0.69$).The meta-analysis showed no obvious difference in infection rate between total hip arthroplasty and hemiarthroplasty ($RR = 2.06$, 95% $CI = 0.67–6.35$, $p = 0.21$, Fig. 5).

Reoperation rate

Four trials[10,12,16,17] involving 767 patients reported reoperation rate. There was no significant heterogeneity and adopting a fixed-effect model of analysis ($I^2 = 0\%$, $p = 0.39$). The pooled data indicated that the application of total hip arthroplasty did not increase the risk of reoperation rate ($RR = 0.69$, 95% $CI = 0.41–1.17$, $p = 0.17$, Fig. 6).

Thromboembolic event

Of the ten studies, five studies[7,8,10,11] reported thromboembolic rate, which included a total of 412 patients. The pooled were performed by using a fixed-effect model for no heterogeneity ($I^2 = 0\%$, $p = 0.44$). The result showed no significant difference between total hip arthroplasty and hemiarthroplasty ($RR = 1.27$, 95% $CI = 0.54–3.01$, $p = 0.59$, Fig. 7).

Publication bias

Ten articles were included in this study. Since the outcome measures were recorded in all the studies, funnel plots of these data were obtained. The funnel plots were not asymmetrical for no obvious evidence of publication bias (Fig. 8). However, publication bias remains questionable for the limited number of included RCTs studies.

Discussion

A femoral neck fracture is a common injury accounting for 23.8% of all fractures[18] and often accompanied by displacement. Currently, the optimal treatment for femoral neck fractures is a vigorously debatable problem. Some scholars found that hemiarthroplasty is superior to total hip arthroplasty for fewer reoperations and better function outcomes.[19–21] However, evidence from a study involving 281 participants[17] showed that there is no difference in the outcome after treatment with either hemiarthroplasty or total hip arthroplasty. Their results remained to be further confirmed due to relatively small patients and insufficient evidence. Therefore, the treatment of choice remains controversial. We compared the outcomes of hemiarthroplasty and total hip arthroplasty in patients with femoral neck fracture. Compared with previous three meta-analyses,[22–24] our study up to now is involved in the largest number of participants and the latest published trials.

As the primary outcome, the mortality rate has been the most important complication in the treatment of femoral neck fracture for the elderly. Our meta-analysis found a significant difference in mortality rate between hemiarthroplasty and total hip arthroplasty. From the result, we concluded that total hip arthroplasty was superior to hemiarthroplasty for hip fracture in mortality at a one-year follow-up. We assumed that this result might be associated with a “total hip “providing better mobility and function, which decreased medical complications such as cardiovascular disease. Increased postoperative activity level provided enormous benefits both physically and mentally.[8] Macaulay et al.[7] reported that the co-morbid condition was a factor affecting mortality. Boukebous and Fahad et al.[11,13] claimed that dual mobility of THA is associated with reduced risk of dislocation without increasing the mortality. In addition, there was difference in the average age of the two groups

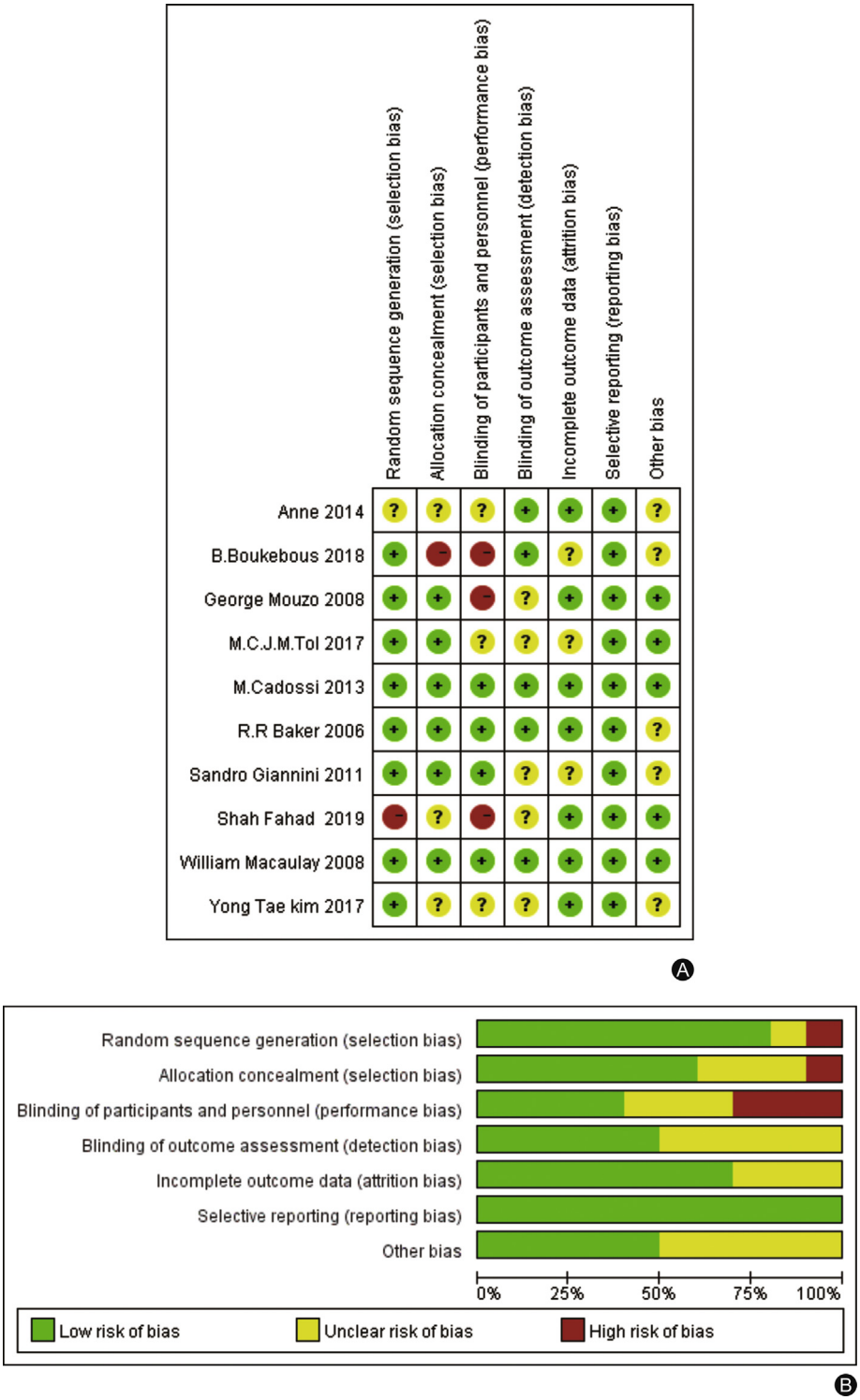

Fig. 2. (A) The results of quality assessment for individual studies; (B) The summary of bias for all included studies. Risk of bias assessment: "+" symbol indicates low risk, "?" indicates unclear risk, and "-" indicates high risk of bias.

of patients. The mean age of patients with hemiarthroplasty was older than that of the total hip arthroplasty. They were not comparable to each other in some trials.[10] There was a certain selection bias. The higher mortality rate in hemiarthroplasty group might be partially explained by the age difference.

How to decrease the dislocation rate was a major concern in our study. Treatment choice was an essential factor that influences the dislocation rate. The results showed that there was a significant difference in the dislocation rate between the two groups. In this meta-analysis, five studies provided data about the dislocation rate.

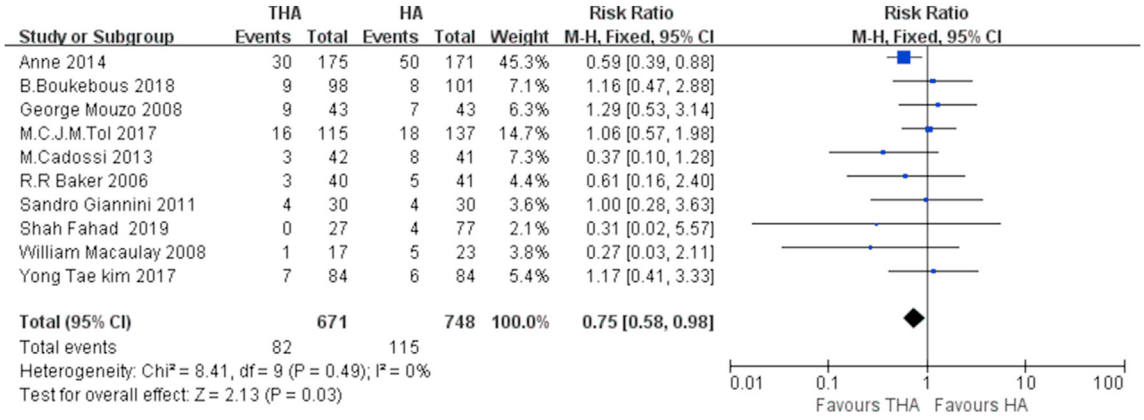

Fig. 3. Forest plot and data table of mean differences in mortality rate of total hip arthroplasty and hemiarthroplasty with 95% confidence intervals.

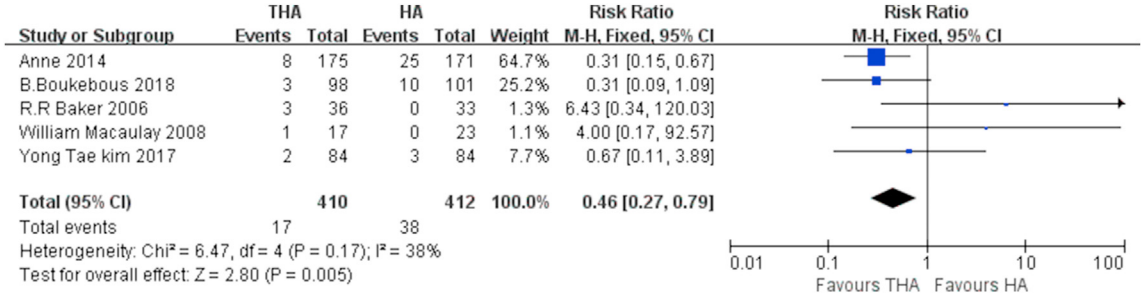

Fig. 4. Forest plot and data table of mean differences in dislocation rate of total hip arthroplasty and hemiarthroplasty with 95% confidence intervals.

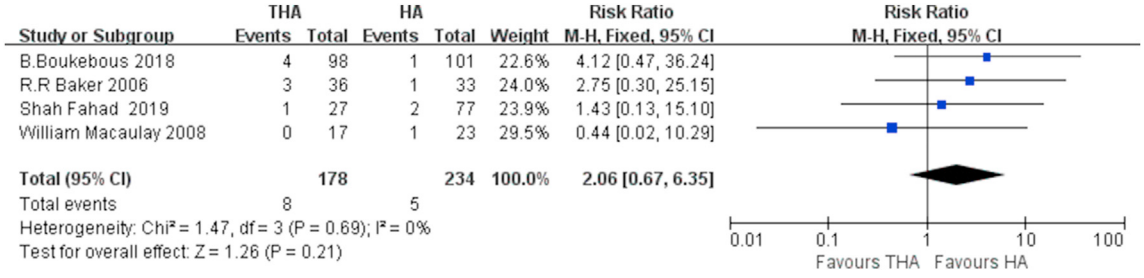

Fig. 5. Forest plot and data table of mean differences in infection rate of total hip arthroplasty and hemiarthroplasty with 95% confidence intervals.

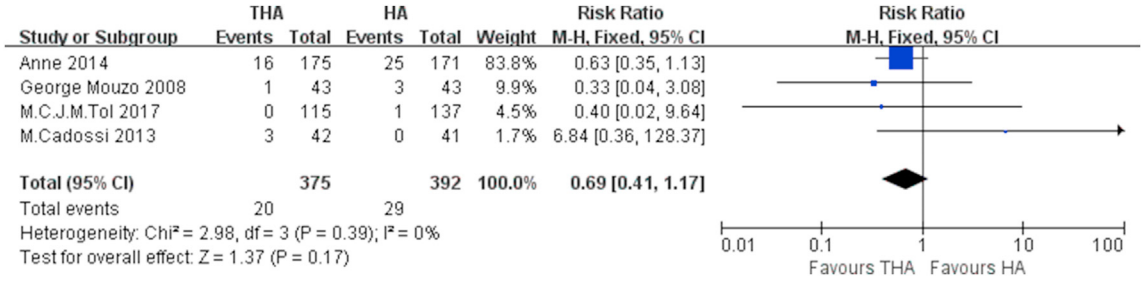

Fig. 6. Forest plot and data table of mean differences in reoperation rate of total hip arthroplasty and hemiarthroplasty with 95% confidence intervals.

Bensen, Boukebous, and Kim et al.[10,11,15] reported a much lower dislocation rate treated with total hip arthroplasty than that with hemiarthroplasty. Total hip arthroplasty improved range of motion, reduced impingement, and provided stability.[25] However, Macaulay and Baker[7,8] noticed that the occurrence of dislocation with hemiarthroplasty is fewer than that of total hip arthroplasty. Many junior surgeons prefer hemiarthroplasty to total hip arthroplasty. The reason may partly explain that the 'learning curve' of total hip arthroplasty is difficult than that of hemiarthroplasty. We tried to find the relationship between treatment choice and the dislocation rate. In our meta-analysis, we found that total hip arthroplasty was superior to hemiarthroplasty. Nich et al.[26] recommended that dual

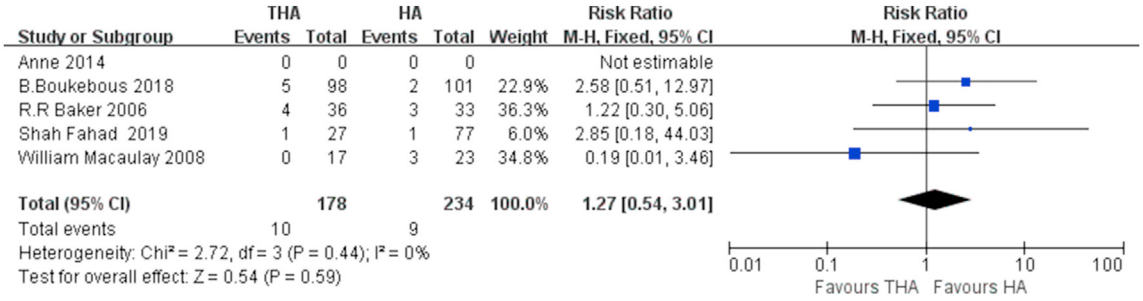

Fig. 7. Forest plot and data table of mean differences in thromboembolic rate of total hip arthroplasty and hemiarthroplasty with 95% confidence intervals.

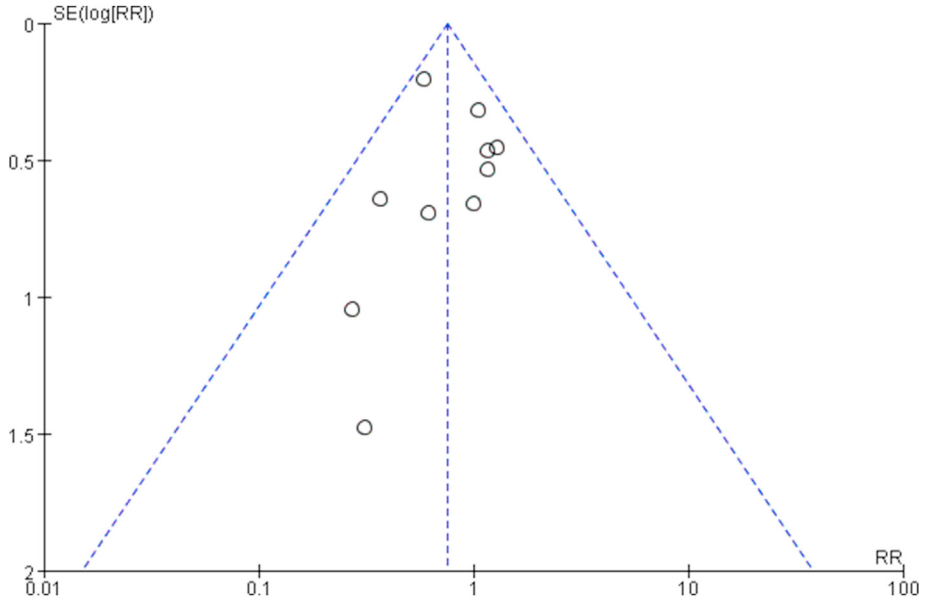

Fig. 8. Funnel plot illustrating a meta-analysis of mortality rate (SE = standard error; *RR* = risk ratio).

mobility cups THA was applied for preventing dislocations and with a low incidence of dislocation. It was possible that part of patients in our study underwent total hip arthroplasty with dual mobility cup,[10] which were not prone to dislocation and therefore the percentage of dislocation events was reduced. In addition, the selection bias was attributed to the surgical approach, surgeon's experience and enhanced repair of posterior soft tissue,[7] which were not taken into account.

The rate of reoperation at a one-year follow-up was revealed no difference between hemiarthroplasty and total hip arthroplasty in our meta-analysis. The choice treatment did not increase patient risk of reoperation rate. Hemiarthroplasty had a lower risk of hip instability than total hip arthroplasty. Early revision or reoperation of total hip arthroplasty was associated with a dislocation. The reoperation rate for loosening, infection, or per prosthetic fracture was similar in the two groups. Wear of acetabular cartilage was not the main reason for revisions or reoperation after hemiarthroplasty for short-term observation.

Regarding infection and thromboembolic events, our meta-analysis revealed no difference between the two groups. Age, sex, high body mass index (BMI), and health condition before surgery increased the risk of infection rate and thromboembolic event.

There were some limitations to consider in this meta-analysis, which should be taken into account. First, the analysis was based on only ten studies, which had a relatively small sample size that may affect results. For limited English language studies, there still had been publication bias in the trials. Second, some unpublished and missing data may have biased the pooled effect. Third, the methodological quality had some problems in the included studies, such as unattainable double-blinding, which may decrease the strength of results. Fourth, there was selection bias. Some unmeasured factors such as preinjury activity level, average age, health conditions, level of self-sufficiency, nutritional status, and psychological well-being of patients were not considered into our study. Finally, the follow-up period was one year. As we know, there are many factors such as aseptic loosening and acetabular erosion may be associated with a risk of reoperation at long-term follow-up.

It is difficult for the surgeon to choose between total hip arthroplasty and hemiarthroplasty for a femoral neck fracture. This meta-analysis would provide some information in guiding the decision making. More participants with a longer follow-up ought to further verify our study.

In conclusion, our meta-analysis of ten studies with 1419 patients indicates that there are no significant differences between hemiarthroplasty and total hip arthroplasty in reoperation, infection rate, and thromboembolic event. However, there is a higher dislocation and mortality rate association with hemiarthroplasty at a one-year follow-up. Total hip arthroplasty has been proved to provide better outcomes than hemiarthroplasty for patients with femoral neck fracture in our study.

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Ethical Statement

This article does not contain any studies with human participants performed by any of the authors.

Declaration of Competing Interest

No conflict of interest exists in the submission of this manuscript, and the manuscript is approved by all authors for publication.

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