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ORIGINAL ARTICLE

Meta-Analysis of Total Hip Arthroplasty versus Hemiarthroplasty in Fracture Neck Femur

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ABSTRACT

Background: Neck femur fractures are considered one of the most dangerous fractures due to their high mortality rate. Detecting the specific manners of the femoral neck fracture is fundamental for surgeons. **Objective:** The present study aimed to provide a better management for the fracture neck femur. **Methods:** This study represents a meta-analysis of literatures that compare between two treatment modalities; Total Hip Arthroplasty (THA) versus Hemiarthroplasty (HA) in the treatment of fractured neck femur. **Results:** The mean ages of both groups showed similar values with a mean of 72.48 ± 7.95 years and 72.63 ± 8.91 years in THA and HA, respectively with statistically insignificant differences ($p > 0.05$). Operation times were more significant in the THA than HA group ($p = 0.032$). Radiological outcomes of the two techniques; excellent results were more in THA than HA ($p = 0.001$), good results were similar in the two groups ($p > 0.05$), and fair and poor results were more in HA than THA ($p < 0.001$). There are more incidences of complications in THA than in HA. **Conclusion:** Total hip arthroplasty has been proven to provide better outcomes than hemiarthroplasty for a proximal femoral fracture at the follow-up periods, however, more complications are detected in THA than HA that may be taken into account.

Keywords: Neck Femur Fracture; Total Hip Arthroplasty; Hemiarthroplasty

INTRODUCTION

Neck femur fractures have a high percentage of occurrences with a severity that equals one-year mortality rate 17 to 24% percent; they also affect the functional mobility of the limb [1].

The rate of neck femur fractures increases basically with age as when people get older; they often have an increased risk of falling from height as they may face problems with vision and balance. Also, the bulk of muscle mass and bone density decreases with age [2].

Neck femur fractures occur in women about 3 times more than in men due to anatomic variations. Women lose bone density faster

than men which leads to osteoporosis due to hormonal changes during menopause [3].

Certain medications like some drugs that cause dizziness, or drugs that act on the central nervous system as antipsychotics and sedatives all of most commonly associated with increasing frequency of falling. Also, corticosteroids, if taken for a long time can weaken the bone. HIV-positive patients on protease inhibitor therapy are more likely to have fractures than those on other agents [4].

Operative options range among hemiarthroplasty, total hip arthroplasty, closed or open reduction, and in situ fixation in simple cases; we may also do an internal fixation. The present discussion focuses on the current methods used for femoral neck fracture management and indications for them to provide appropriate and efficient care for these injuries [5].

Up till now, Garden and Pauwels systems of classification are considered as a practical cornerstone of femoral neck fracture description that helps in recommending the convenient treatment [6]. The hypothesis of this study is HA and THA are commonly used to treat femoral neck fractures, but each has disadvantages and the optimal treatment of these fractures remains controversial. Therefore, the present study aimed to provide a better management for the fracture neck femur.

METHODS

This is a systematic review study and meta-analysis on human subjects studied in different literatures collected from different medical websites in the period from 2016 to Dec 2022 that studied Total Hip Arthroplasty (THA) versus Hemiarthroplasty (HA) in the treatment of fracture neck femur. The study was performed in the Orthopedic Surgery Department, Faculty of Medicine, Zagazig University along the period from May 2022 to Feb 2023.

Types of participants

Old age patients diagnosed with having primary fracture neck femur with efficient hip and femur ligaments with no previous history of hip or femoral injury and with stable hip joint.

Search strategy

The search was conducted by using the databases: JBJS (Journal of Bone and Joint Surgery), Medline PubMed library, developed by the National Center for Biotechnology Information (NCBI) of the US National Library of Medicine (NLM), and in the library of the Cochrane Database (http://www.cochrane.org) as well as Google Scholar search that published later than the year 2016.

The following keywords: "Unicompartmental knee arthroplasty, total knee arthroplasty, Treatment of Unicompartmental Knee Osteoarthritis" were used for published studies from 2016 onwards.

The search was limited to studies that directly compared outcomes of THA and HA, in old age patients (age ≥55 years) with fractured neck femur. All included literature must be in English language whether British or American English.

Inclusion criteria

Literature previously published from the year 2016 up till now. Published studies or ahead for publishing full-text articles. Article type: randomized control trials, clinical trials, retrospective analyses, comparative studies and. large cohort studies. Studies comparing total hip arthroplasty with hemiarthroplasty in fractured neck femur using Lateral approach. Articles in English languish only.

Exclusion criteria

Articles published outside the selected range

(before the year 2016). Article abstract, full-text version unavailable. Articles written in other languish than English unless it can be translated to English. Low age patients <55 years. Pathological fracture, i.e., neoplasm. Studies for surgically unfit patients. Duplicated articles for the same authors, the most recent article only was included. Studies with other approaches than lateral one. Case report articles and literature reviews. Articles with no clinical data. Articles not comparing outcomes. Articles not published in peer-reviewedjournals.Biomechanical or cadaveric studies.Studies with insufficient to pool for statistical analysis.

The literature search demonstrated multiple studies comparing differences in implant design, surgical approach, blood loss or transfusion rates, complications, operative time, and hospital stay of THA versus HA. These aspects of surgical techniques were not included in the analysis of this study because we only focused on the outcome of both techniques.

Locating and selecting studies:

Abstracts of articles identified using the above search strategy were viewed, and articles that appeared to fulfill the inclusion criteria were retrieved in full, when there was a doubt, a second reviewer assessed the article, and consensus was reached.

Data extraction

Data were independently extracted by use of standardized forms by two reviewers and cross-checked, Outcomes from included trials were combined using the systematic review manager software and manually screened for eligibility to be included.

The data recorded included general study characteristics such as the name of the lead investigator and year of publication, recruitment period, median duration of follow-up, number of participants, and mean age and sex of the participants. Furthermore, the primary outcome measures and adverse event data or complications were extracted.

Selection of domains of outcomes to be investigated:

The outcome measures were identified after discussion groups in our unit, about patients who had previously undergone knee arthroplasty surgery. We also took into account the most commonly used measures of outcome from recent publications. Domains include length of operation and length of hospital stay, risk of early complications, success of operation, reoperation or revision rate, and rate of recovery.

ETHICAL APPROVAL

Approval of the study was obtained from the Zagazig University Academic and Ethical Committee. Written informed consent of all the participants was obtained. This work has been carried out by The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

STATISTICAL ANALYSIS

Data were coded, entered and analyzed by computer software package (version 10). Data were presented as Mean ± SD for quantitative variables & number and percentage for qualitative variables. Categorical data were compared using chi-square. The significance level was considered at P-value <0.05 for ANOVA and t-student test was used to differentiate between two different variables. Statistical analysis was done using the Jamovi project (2019) [*jamovi* Version 1.0 Computer Software. Retrieved from ttps://www .jamovi.org]. Studies included in the meta-analysis were tested for heterogeneity of the

estimates using the following tests including Cochran Q Chi-square test and the I-square (I2) index. Binary outcomes were presented as proportion and 95% CI. Estimates from included studies were pooled using the restricted maximum-likelihood (RML) random-effects method (REM).

RESULTS

This systematic review study on human subjects studied in different literatures collected from different medical websites in the period from 2016 to the end of 2022 in whom comparison between total hip arthroplasty and hemiarthroplasty was performed for patients with fractured neck femur. Ten (10) literature had fulfilled the study criteria were included in this study according to the PRISMA figure (Figure 1).

The study showed that the incidence of HA was significantly higher ($p < 0.001$) than THA in the studied literature in females and males as well as in total cases. However, females were more common than males in femoral neck fractures. The mean ages of both groups showed similar values with a mean of 72.48 ± 7.95 years and 72.63 ± 8.91 years in THA and HA, respectively with statistically insignificant differences ($p > 0.05$). The mean body mass index between the two groups was similar ($p > 0.05$). The mean follow-up period between the two groups was similar ($p > 0.05$) (Table 1).

Operation times were more significant in the THA than HA group ($p = 0.032$). However, hospital stay was similar in the two groups ($p > 0.05$) (Table 2).

Radiological outcomes of the two techniques; excellent results were more in THA than HA ($p = 0.001$), good results were similar in the two groups ($p > 0.05$), and fair and poor results were more in HA than THA ($p < 0.001$). No failure observed in THA, while 8.33% of patients has failure in HA group (Table 3).

Regarding Harris Hip Score (HHS) for pain. It showed a statistically significant difference ($p = 0.022$) between THA and HA. There is more improvement in HHS in THA than in HA (Table 4).

There was a statistically highly significant difference ($p = 0.001$) between THA and HA in the values of the operative blood loss. There is more blood loss in THA than HA. Pooling of studies using random-effects method (REM) with 95% CI. There is considerable heterogeneity (I2 =98.7%), and a statistically highly significant difference ($p < 0.001$) in the transverse comparison between THA and HA (Table 5).(OR Figure in the list of responses).

The total postoperative complications. It showed statistically highly significant difference ($p < 0.001$) between THA and HA. There are more incidences of complications in THA than HA (Table 6).

Table 1: Demographic data of THA and HA in the studied literature.

	THA	HA	t	P
Age (years)				
Range Mean ±SD	55.19 – 85 72.48 ± 7.95	55.21 – 86 72.63 ± 8.91	0.031	0.869
Males: No. (%)				
Range Mean ±SD	8 – 568 111.13 ± 196.2	8 – 1455 224.5 ± 502.3	4.893	0.000*
Females: No. (%)				

	THA	HA	t	P
Range Mean ±SD	12 – 1305 248.75 ± 459	13 – 3121 473.6 ± 1082.5	4.165	0.000*
BMI (Kg/m2)				
Range Mean ±SD	22.1 – 29.08 25.55 ± 2.96	21.9 – 26.69 24.95 ± 1.97	0.045	0.854
Follow-up (years)				
Range Mean ±SD	9 – 36 19.84 ± 9.5	9 – 36 20.19 ± 9.69	0.038	0.862

*t= unpaired t-test, *p <0.001: highly significant, p >0.05: non-significant, BMI: body mass index*

Table 2: Operative time and hospital stay in THA and HA operations.

Operative time	THA	HA	t	P
Range (min) Mean ±SD (min)	63.72 – 124.28 90.59 ± 19.54	57.77 – 112.29 72.39 ± 19.19	0.656	0.032*
Hospital stays				
Range (days)	4.6 – 19.92	4.04 – 18.32		
Mean ±SD (days)	13.91 ± 6.73	13.39 ± 6.658	0.009	0.988

*t= unpaired t-test, *p <0.05: significant.*

Table 3: Radiological outcomes in THA and HA techniques.

Outcome	THA	HA	t	P
Excellent	35.46 ± 7.71	23.64 ± 15.75	1.891	0.001*
Good	55.0 ± 7.07	51.18 ± 7.56	0.358	0.132
Fair	6.27 ± 2.45	11.595 ± 7.18	-1.905	0.001*
Poor	3.27 ± 1.796	9.42 ± 10.25	-6.824	0.000*
Failure	0 %	8.33 %		

*t= unpaired t-test, *p <0.001: highly significant.*

Table 4: Meta-analysis for Harris Hip Score of pain in THA and HA groups.

HHS	THA		HA		t	P
Range	39.7 – 92.28		35.42 – 88.31			
Mean ±SD	71.96 ± 22.45		64.8 ± 22.79		0.789	0.022*
OR (THA-HA)	Min (0.325)		Max (2.606)		Mean (1.466)	
95% CI	LB	UB	LB	UB	LB	UB
Intercept	- 1.417	1.314	1.967	3.898	0.275	2.606

t= Paired t-test, OR: Odds ratio, CI: confidence interval, SD: standard deviation. LB: lower bond, UB: upper bond, p <0.05 = significant.

Table 5: Meta-analysis for operative blood loss in THA and HA groups.

HHS	THA		HA		t	P
Range	178.2 – 1520		125 – 650			
Mean ±SD	521.1 ± 466.2		331.8 ± 185.5		1.976	0.001*
OR (THA-HA)	Min (0.855)		Max (5.655)		Mean (3.255)	
95% CI	LB	UB	LB	UB	LB	UB
Intercept	0.014	1.643	1.718	9.592	0.866	5.618

t= Paired t-test, OR: Odds ratio, CI: confidence interval, SD: standard deviation. LB: lower bond, UB: upper bond, p <0.05 = significant.

Table 6: Meta-analysis for postoperative complications of both THA and HA groups.

HHS	THA		HA		t	P
Mean (%)	56.3		27.3		2.391	0.000*
OR (THA-HA)	Min (0.855)		Max (5.655)		Mean (3.255)	
95% CI	LB	UB	LB	UB	LB	UB
Intercept	0.014	1.643	1.718	9.592	0.866	5.618

t= Paired t-test, OR: Odds ratio, CI: confidence interval, SD: standard deviation. LB: lower bond, UB: upper bond, p <0.05 = significant.

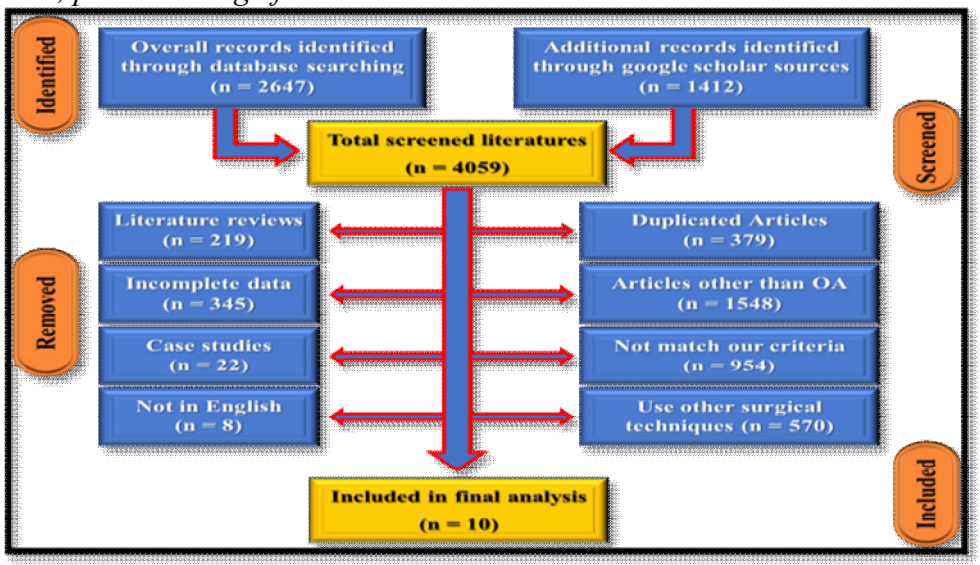

Fig. 1: PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) search strategy for our study selection.

DISCUSSION

The person-based incidence of femoral neck fractures in adults was 1.6 million globally every year, which is expected to increase to over 6 million worldwide by the year 2050 [7].

This systematic review study on human subjects studied in different literatures collected from different medical websites in the period from 2010 to the end of 2022 in whom a comparison between THA and HA was performed for patients with fractured neck femur. Ten (10) literatures had fulfilled

the study criteria were included in this study to compare between THA and HA techniques regarding outcomes and complications. We suppose that this study provides more useful evidence for clinical decisions.

For a proximal femoral fracture, our finding revealed that total hip arthroplasty has been shown to offer better results than hemiarthroplasty at follow-up intervals; nevertheless, there have been more problems reported with THA than HA, which may be taken into consideration. Because the cases is associated with osteoporosis and arthrosis, on other hand the complication is related to the technique (the THA is more vigours and needed bigger approach).

A previous systematic review in 2020 had similar number of literatures (10 studies) in total of 1419 patients (we had more patients 8634 in 10 studies) [7].

The study showed that the HA (65.71%) was more than THA (34.29%). Females were more prone to fracture neck femur than males. In THA, 68.76% females compared to 31.24% males and in HA, 67.67% females compared of 32.33% males. So, the rates in female were nearly double that of males. The incidence of HA was significantly higher ($p < 0.001$) than THA in the studied literature in females and males as well as total cases. However, females were more common than males in femoral neck fractures. So, the incidence of HA was about two thirds of the cases, while the incidence of THA represent only one third.

In agreement with our study, a large systematic review in 19 studies included total of 458,113 patients; 413,140 patients (90%) in the HA group and 44,973 patients (10%) in the THA group [8,9].

On the other hand, the meta-analysis of Liu et al.[10] had similar number of patients in the two groups in their 9 literatures studied included 631 participants.

The mean ages of both groups showed similar values with mean of 72.48 ± 7.95 years and 72.63 ± 8.91 years in THA and HA, respectively with statistically insignificant difference ($p > 0.05$). Similar to our results, Bensen et al. [11]found that both groups were not comparable to each other regarding age.

On contrary to our results, Peng et al. [7]found that there was difference in the average age of the two groups of patients. The mean age of patients with hemiarthroplasty was older than that of the total hip arthroplasty. They added that there was a certain selection bias. The higher mortality rate in hemiarthroplasty group might be partially explained by the age difference.

Liu et al.[10] stated that the frequency of HA procedures increases with age, whose cutoff is at 76, due to, in part, the contradictions between the more extensive surgery of THA and the lower surgical tolerance of elderly patients [11,12].

The mean follow-up period between the two groups were similar ($p > 0.05$). The mean body mass index between the two groups were similar ($p > 0.05$). Our mean follow-up was 19.84 ± 9.5 months and 20.19 ± 9.69 months in THA and HA, which longer than Liu et al.[10] with mean of 14.5 months and Peng et al. [7]with mean of 12 months.

The present study showed that operation times were more significant in THA than HA group ($p = 0.032$). However, hospital stay was similar in the two groups ($p > 0.05$).

In agreement with these results, Liu et al.[10] in their meta-analysis found three studies assessed the operative time in both the THA and the HA groups (123 with THA and 117 with HA).

The operative time was significantly longer

in the THA group (MD 18.20, 95% CI 9.99–26.41, and heterogeneity across the studies was 46%. The THA group had a longer average operative time and a higher dislocation rate, with a trend towards higher general complication rates, and longer duration of hospital stays. Moreover, there was no significant difference in terms of reoperation rate, postoperative infection, peri-prosthetic fractures, and VTE prevalence across the groups.

Similarly, Li and Luo [13]in the Forest plot for the complication found in total, 10 studies were included, containing 32,731 patients in the HA group and 6731 patients in the THA group. Based on a Chi-squared $P = 0.000 < 0.05$ and an $I2 = 99.9\% > 50\%$, a random-effects model was chosen to assess surgery time. The surgery time was significantly decreased in the HA group than THA group (WMD, −12.28; 95% CI, −13.07 ~ −11.49). In contrast to our results, two studies assessed the length of hospital stay in both groups from 292 interventions ($I2 = 0\%$). The data tended to favor the HA group (MD 1.30, 95% CI −0.43–4.57) [9,14].

The current study shows that radiological outcomes of the two techniques were excellent results which are more in THA than HA ($p = 0.001$), good results were similar in the two groups ($p > 0.05$), fair and poor results were more in HA than THA ($p < 0.001$). No failure observed in THA, while 8.33% of patients has failure in HA group.

However, evidence from a study of Tol et al. [14] involving 281 participants 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.

The study shows that Harris hip score (HHS) for pain showed more improvement in THA than HA ($p = 0.022$). Forest plot for HHS shows that there is a considerable heterogeneity ($I2 = 94\%$) with statistically significant difference in HHS in transverse (row) comparison between THA and HA ($p < 0.01$). Rank correlation test and regression analysis for funnel plot asymmetry were significant ($p = 0.0173$) for longitudinal comparison (column comparison) between THA and HA in postoperative values.

In our series, the THA group had better total HHS outcomes in the follow-up period. Similarly, Liu et al.[10] had the same results in short (1 year) and medium term (5 years). These results were supported by previous studies [9,15,16].

On the other hand, Lewis et al. [17] found no significant difference in total HHS and pain HHS in patients over 80 years.

Whether the superior hip function of THA in this population still exists in the long term is controversial, whereas there is not enough data for our study.

The heterogeneity might be associated with the differences in surgical techniques and rehabilitation programs because the two RCTs had similar inclusion criteria, patients' characteristics, and prosthesis types [18,19].

Liu et al.[10] divided the data into two subgroups according to the follow-up duration (within 1 year and from 1 to 5 years). Two studies assessed the HHS pain within 1 year ($I2 = 0\%$).

In the present study, THA had more serious complications than HA ($p < 0.001$). There is more incidences of complications in THA than HA. Forest plot for the total postoperative complications of both THA and HA shows a considerable heterogeneity ($I2 = 99.1\%$), statistically highly significant

difference ($p < 0.001$) in transverse comparison between THA and HA. Funnel plot for the postoperative complications for THA and HA. There is no evidence of publication bias with symmetrical funnel plot. Rank correlation test & regression analysis for funnel plot asymmetry were highly significant ($p = 0.001$), for longitudinal comparison between THA and HA, operative values.

As the primary outcome, the mortality rate has been the most important complication in the treatment of femoral neck fracture for the elderly. The meta-analysis of Peng et al. [7] found a significant difference in mortality rate between hemiarthroplasty and total hip arthroplasty.

From the result, they concluded that total hip arthroplasty was superior to hemiarthroplasty for hip fracture in mortality at a one year follow-up. They assumed that this result might be associated with a "total hip "providing better mobility and function, which decreased medical complications such as cardiovascular disease. In addition, there was difference in the average age of the two groups of patients. The mean age of patients with hemiarthroplasty was older than that of the total hip arthroplasty. The higher mortality rate in hemiarthroplasty group might be partially explained by the age difference.

In contrast to our results, Liu et al.[10] found that the HA group had lower rates of general complications ($I2= 0\%$), there was no significant difference from the THA group (RR 1.28, 95% CI 0.89–1.86). Three studies assessed the infection rates of both groups from 339 interventions ($I2 = 0\%$) [18-21].

Pooling the data of the included studies elicited no significant statistical difference between the THA and HA groups (RR 1.51, 95% CI 0.55–4.15). Also, in contrary to our results, Li and Luo [13]in the Forest plot for the complication found in a total, 11 studies were included in their meta-analysis containing 38,129 patients in the HA group and 11,633 patients in the THA group. Based on a Chi-squared $P= 0.000 < 0.05$ and an $I2 = 73.3\% > 50\%$, a random-effects model was chosen to assess complication. The incidence of complication has no significant difference between the two groups (RR, 1.18; 95% CI, 1.00 ~ 1.39).

The reason may partly explain that the 'learning curve' of total hip arthroplasty is difficult than that of hemiarthroplasty.

Peng et al. [7] tried to find the relationship between treatment choice and the dislocation rate. In their meta-analysis, THA was superior to HA.

Nich et al. [22] recommended that dual mobility cups THA was applied for preventing dislocations and with a low incidence of dislocation.

The rate of reoperation at a one-year follow-up was revealed no difference between hemiarthroplasty and total hip arthroplasty inmeta-analysis [7].

The choice of treatment did not increase the patient's 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. The wear of acetabular cartilage was not the main reason for revisions or reoperation after hemiarthroplasty for short-term observation [23].

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 [7].

Currently, there are many surgical methods to treat proximal femoral fractures, but generally speaking, it is generally agreed that the better method is artificial joint replacement. Currently, HA and THA are widely used, and both advantages and disadvantages exist in clinical practice. Hip replacement can significantly reduce the incidence of postoperative joint pain in patients, and because of the patient's early weight-bearing walking, it is very important to maintain the muscle strength of the affected limb and restore good overall health. [13].

The advantage of our study is that THA is superior to hemiarthroplasty for the treatment of mentally competent, independent, and active patients. Also, better functional outcomes, fewer complications, and fewer revisions after follow-up.

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 the 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 the results. Fourth, there was selection bias. Some unmeasured factors such as preinjury activity level, average age, health conditions, and level of self-sufficiency, nutritional status, and psychological well-being of patients were not considered into our study. Finally, we could only perform subgroup analyses according to age because of not enough data for the subgroup analyses based on comorbidities and ASA score. Pooled data were analyzed, as individual patient data was not available, precluding more in-depth analyses.

CONCLUSION

Total hip arthroplasty has been proven to provide better outcomes than hemiarthroplasty for a proximal femoral fracture at the follow-up periods, however, more complications detected in THA than HA may be taken into account.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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