

## Review Article

# Comparison of hemiarthroplasty versus internal fixation in treatment of displaced femoral neck fracture: a meta-analysis

Yanjiang Yang<sup>1\*</sup>, Juan Wang<sup>1\*</sup>, Jiayuan Sun<sup>1</sup>, Lei Liu<sup>1</sup>, Qi Zhang<sup>1</sup>, Yingze Zhang<sup>1,2</sup>

<sup>1</sup>Department of Orthopaedic Surgery, The Third Hospital of Hebei Medical University, Shijiazhuang 050051, Hebei, P. R. China; <sup>2</sup>Key Laboratory of Biomechanics of Hebei Province, Shijiazhuang 050051, Hebei, P. R. China. \*Equal contributors.

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**Abstract:** This meta-analysis of randomised controlled trials (RCTs) aimed to investigate the comparative outcomes between hemiarthroplasty (HA) and internal fixation (IF) for management of displaced femoral neck fractures. Relevant original studies were searched in electronic databases of Embase, CNKI, Medline, and Cochrane central database (all through October 2015). RCTs that investigated the effectiveness or complications between both groups and provided sufficient data of interest were included in this meta-analysis. 14 RCTs fulfilled inclusion and exclusion criteria and were included in this meta-analysis, with 1270 participants in the IF group and 1425 in the HA group. Patients were followed up for at least one year in all the studies. Compared to IF, HA is a better alternative for treatment of displaced femoral neck fracture in the elderly, with reduced major complications and reoperations, better hip pain relief and favorable hip function in the long run. There were no statistically significant differences between the groups in the incidence of wound infection, deep vein thrombosis, pulmonary embolism, haematoma, pressure sores, cerebrovascular accident, respiratory infection and urinary tract infection. HA has more advantages than IF for treatment of displaced femoral neck fracture, and could be a better alternative if surgery was indicated. This definitive conclusion could help surgeons in making evidence-based decisions when selecting an optimal fixation pattern.

**Keywords:** Displaced femoral neck fracture, hemiarthroplasty, internal fixation, RCTs, meta-analysis

## Introduction

Displaced femoral neck fractures represent approximately 33.6% of hip fractures [1]. The best treatment for displaced femoral neck fracture is still to be determined. Hemiarthroplasty (HA) or closed reduction and internal fixation (IF) with nails or screws are the two main options for the treatment of displaced fractures of femoral neck. Some authors recommend IF for young patients in good physical health status and HA for elderly patients [2, 3], whereas other authors recommend that IF is a better choice for all age groups [4] or claim HA as the safest primary mode of treatment [5, 6]. IF required less operation time [2, 7, 8], accompanied by less operative blood loss [7, 9], lower risk of infection [7, 10], and possibly a lower

early mortality rate [8]. HA complications included prosthetic head dislocation [6, 10, 11], stem loosening [2], and acetabular protrusion [2, 6], however HA had a lower reoperation rate compare with IF for the treatment of displaced fractures of femoral neck [8, 11-13]. Gao et al [14] conducted a meta-analysis comparing internal fixation with arthroplasty ( hemiarthroplasty or total hip replacement) for displaced femoral neck fractures. However, the type of arthroplasty (hemiarthroplasty or total arthroplasty), approach (anterior, anterolateral or posterior), and method of fixation (open or closed), fixation method (screws or others), may have an impact on the final treatment effect [15]. Accordingly, we focused on the types of arthroplasties and conducted a meta-analysis of RCTs to evaluate early and late mortality, reoperation rate, major

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surgical complications, and function in displaced femoral neck fracture patients treated with either HA or IF.

## Materials and methods

### Search strategy

Embase, CNKI, Medline, and Cochrane central database were searched using a broad range of terms to identify original research, published all through October 2015 and identified potentially studies. The main key words were as follows: “displaced femoral neck fractures” and “internal fixation” AND “hemiarthroplasty” or “prosthetic replacement”. Also, a manual search of references in the identified articles and systematic reviews was performed for possible inclusion.

### Eligibility criteria

Two reviewers (Wang Juan and Pan Hu) independently evaluated the titles and abstracts of the identified studies. Only full-text articles without language restriction were included in this meta-analysis. The following inclusive selection criteria were applied: (1) randomized controlled trials comparing the results between HA and IF for treating displaced femoral neck fractures; (2) studies with at least one year follow-up; (3) elderly people ( $\geq 60$  years age) with an acute displaced femoral neck fractures; (4) sufficient data were provided for estimating an odds ratio (OR) or standard mean difference (SMD) with 95% confidence interval (95% CI).

### Quality assessment and data extraction

The quality of the included articles was evaluated using the modified Jadad scale [16]. It is designed to evaluate randomization, blinding, withdrawals and dropouts, inclusion and exclusion criteria, adverse effects and statistical analysis based on the eight-item scales. The score for each trial ranges from 0 to 8 points, with 4 to 8 denoting good to excellent quality and 0 to 3 poor to low quality. All the data were independently and carefully extracted from the eligible studies by the same two reviewers (Wang Juan and Pan Hu). The following basic characteristics were extracted from each article: first author's name, publication year, patients' gender and age, follow-up duration, definitions and numbers of HA and IF groups, and numbers of citations for each observed item.

### Postoperative results evaluation

The clinical results assessed in this study included: early and late mortality, incidence of the major complications, superficial or deep infection, postoperative hematoma, deep vein thrombosis and pulmonary embolism, with or without the need of reoperation. The definition of major surgical complications for IF included deep infection, nonunion and avascular necrosis, whereas the major complications of HA included acetabular erosion, deep infection, dislocation, prosthesis loosening and periprosthetic femoral fracture. The definition of reoperation excluded the removal of implant after fracture healing and closed reduction of prosthesis dislocation. Scales assessing the function included the Harris hip score [17], Eq-5d [18].

### Statistical analysis

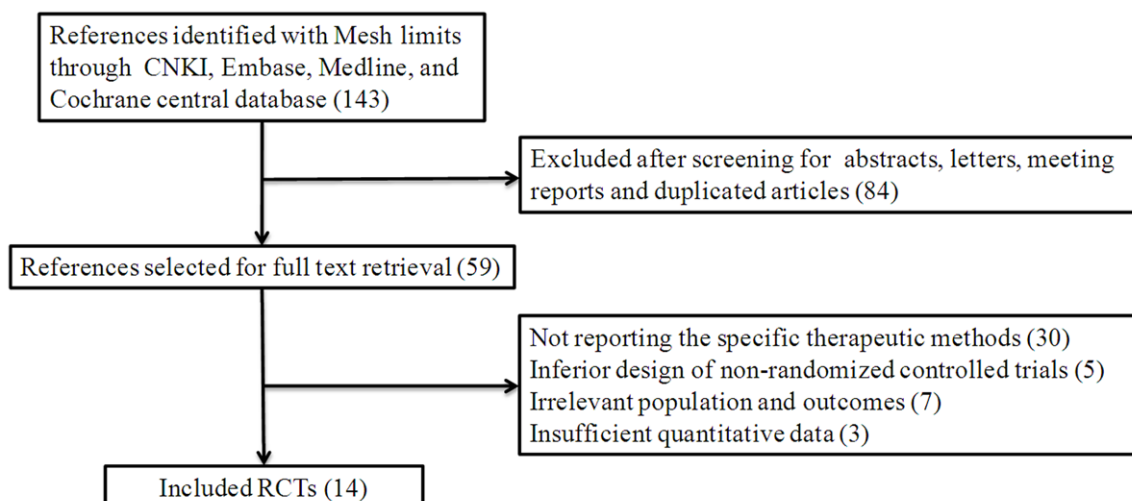
ORs or SMDs and corresponding 95% CI were estimated and pooled across studies to assess the discrepancy between the two methods with a value of  $P < 0.05$  as significant. Heterogeneity among studies was tested by Q-test statistics with significance set at  $P < 0.10$  [19]. The  $I^2$  statistics was used as a quantitative measure of heterogeneity, with  $I^2$  more than 50% indicating significant inconsistency. A random effects model was adopted to calculate pooled ORs in the case of significant heterogeneity ( $P < 0.10$  or  $I^2 > 50\%$ ); otherwise, a fixed-effects model was used. The meta-analysis of significant variables were summarized graphically using a forest plot. Publication bias was assessed by Begg's test and graphed by a funnel plot, a  $P < 0.10$  was considered significant. If necessary, a sensitive analysis by excluding outlier study one by one was conducted to investigate the sources for heterogeneity. All analyses were performed using the software Stata 11.0 (Stata Corporation, College Station, TX).

## Results

### Research results and basic information

A total of 143 potential citations were identified; 84 were excluded due to inappropriate types (e.g., abstracts, duplicated articles, meeting reports or letters); 30 were excluded for not reporting the specific therapeutic methods according to criteria; 5 were excluded due to

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**Figure 1.** Flow diagram showing the process of selection for meta-analysis.

**Table 1.** Detailed information on the basic characteristics of the 14 RCTs and participants

Author	Country (area)	Publication year	HA (case)	IF (case)	HA age (mean)	IF age (mean)	Follow-up (months)
Soreide [20]	Norway	1979	53	51	78.3	77.9	12
Sikorski [6]	England	1981	114	76	80.4	79.2	24
van Vugt [2]	Netherlands	1993	22	21	76.0±3	75.3±3	36
Ravikumar [10]	UK	2000	91	91	82.1	79.7	156
Davison [22]	England	2001	93	187	75	73	36
Puolakka [23]	Finland	2001	15	17	82	81	24
Parker [7]	England	2002	229	226	82.4	82.2	36
Rodén [21]	Sweden	2003	47	53	81	81	60
Blomfeldt [24]	Sweden	2005	30	30	84.0±5.9	83.6±6.3	24
Bjorgul [11]	Norway	2006	455	228	82	82	12
Keating [8]	UK	2006	111	118	75.4±7	74.9±7	24
Frihagen [9]	Norway	2007	110	112	82.5±7.32	83.2±7.65	24
Hedbeck [12]	Sweden	2013	29	30	85.2±5.5	83.8±5.4	24
Parker [13]	UK	2015	26	30	81.2	81.5	12

the design of non-randomized controlled trials; 7 were excluded for irrelevant population and outcomes; 3 were excluded as they did not provide sufficient data for meta-analysis; and finally, 14 RCTs were identified to be eligible. The whole research procedure was presented by a flow diagram (**Figure 1**). The fourteen comparative RCTs published from 1979 to 2015, covered 1270 participants in the IF group and 1425 in the HA group, respectively. There were 623 males and 2072 females in the 14 RCTs. Participants in these studies were followed up at least 12 months. A summary of basic characteristics is listed in **Table 1**.

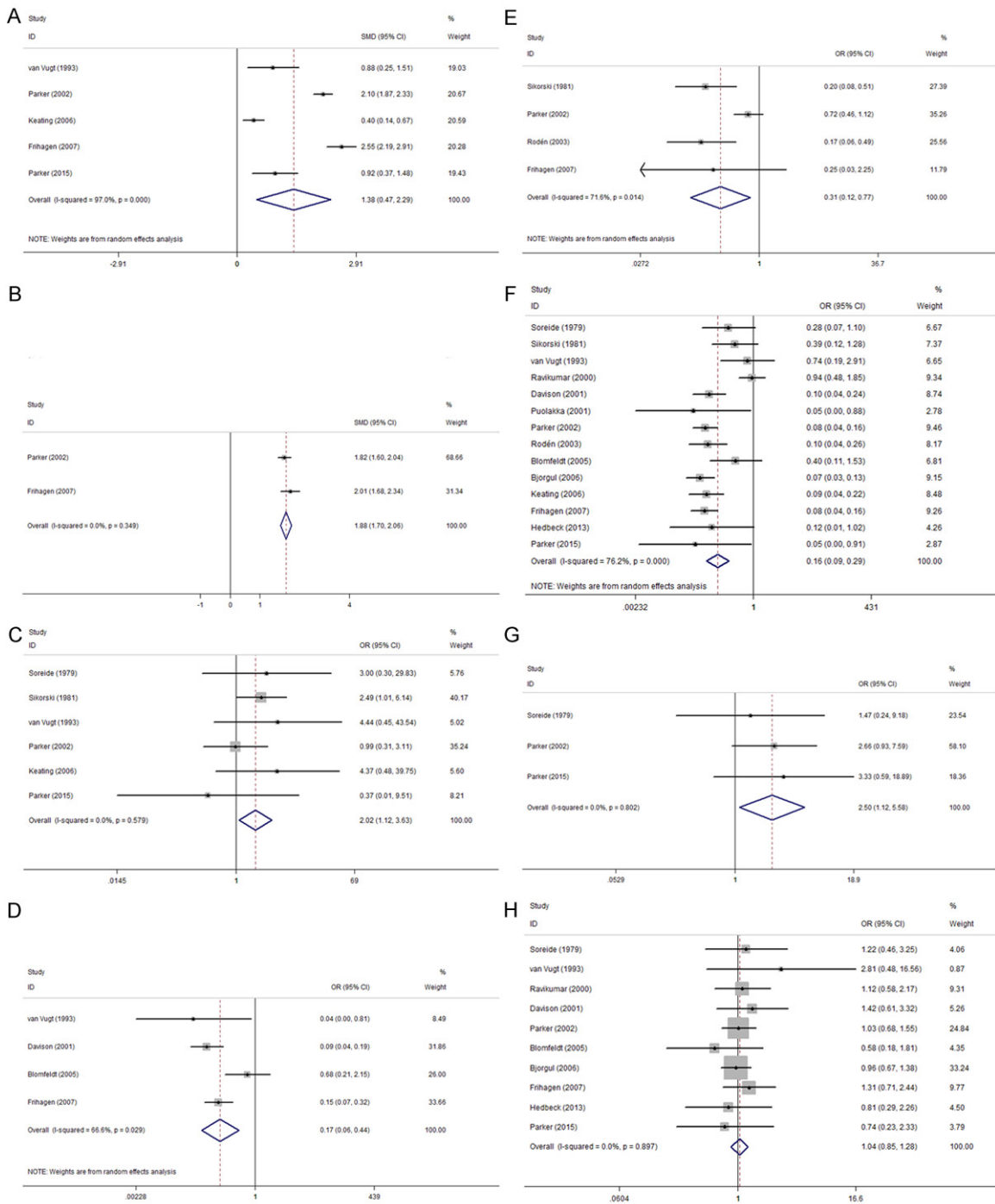
### Quality assessment of studies

The 14 RCTs were relatively well designed, and the quality assessment score was high with a range from 4 to 7 points; no articles scored 8 points because of the absence of double-blindness. Detailed assessment was presented as follows: three study scored 4 [6, 13, 20]; four study scored 5 [8, 10, 12, 21], six studies scored 6 [2, 7, 11, 22-24] and one scored 7 [9].

### Perioperative variables

Five studies reported surgery time, with means of 65.6 and 43.4 min in HA and IF groups,

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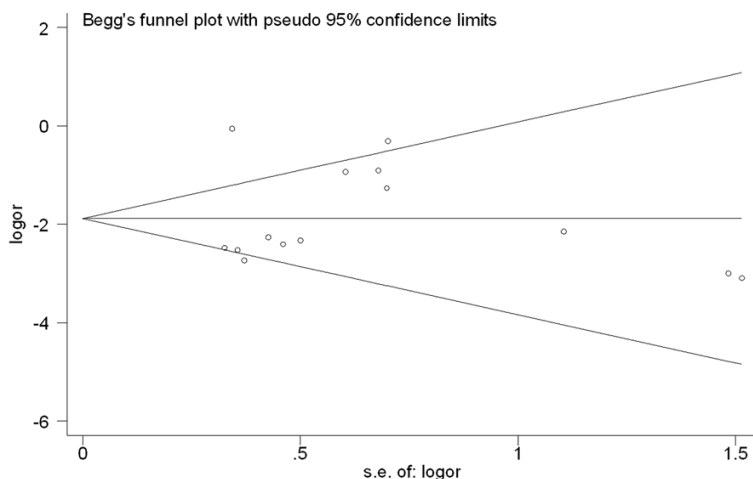


**Figure 2.** A. Forest plots for surgery time. B. Forest plots of the meta-analysis of operative blood loss. C. Forest plots of the meta-analysis of cardiac failure. D. Forest plots of the meta-analysis of major complications. E. Forest plots of the meta-analysis of hip pain. F. Forest plots of the meta-analysis of reoperation rate at one year postoperative. G. Forest plots of the meta-analysis of urinary retention. H. Forest plots of the meta-analysis of mortality rate at one year.

respectively, and the discrepancy approached to significance (SMD, 1.38; 95% CI, 0.47 to

2.29) with obvious heterogeneity ( $I^2=97\%$ ) (Figure 2A). However, no sensitivity test was

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**Figure 3.** Begg's funnel plot for publication bias (with 95% pseudo confidence limits) of the studies that investigated reoperation at one year postoperative between HA and IF group ( $P=0.189$ ).

necessary because significant difference was observed in each trial, indicating the result reliable.

Operative blood loss was reported by only two studies, with less blood loss in the IF group than the HA group (262.5 ml vs 31.5 ml). The meta-analysis for pooled results from two studies showed the significant discrepancy (SMD, 1.88; 95% CI, 1.70 to 2.06) without any heterogeneity ( $I^2=0$ ) (**Figure 2B**).

Six studies reported the incidence of cardiac failure, with 7.2% of the HA group and 3.3% of the IF. The meta-analysis investigated a significant difference without any heterogeneity (OR, 2.02; 95% CI, 1.12-3.63;  $I^2=0$ ) (**Figure 2C**).

### *Postoperative complications*

Four studies reported the major complications, although with a significantly lower incidence rate in HA than IF groups, and the combined result reached significance (OR, 0.17; 95% CI, 0.06-0.44) with heterogeneity ( $I^2=66.6\%$ ) (**Figure 2D**). After sensitive analyses, heterogeneity was resolved and the significance did not change (OR, 0.11; 95% CI, 0.07-0.19;  $I^2=0$ ).

Four RCTs including 796 patients were compared for postoperative pain. Patients treated with HA reported less pain than patients treated with IF (OR, 0.31; 95% CI, 0.12-0.77) (**Figure 2E**).

All fourteen RCTs including 1447 HAs and 1167 IFs reported the reoperation rate at one year postoperative. The reoperation rate in the HA group was 6.5% and in the IF group 34.6%, and the pooled results for meta-analysis suggested a significant difference (OR, 0.16; 95% CI, 0.09-0.29) (**Figure 2F**). Begg's funnel plot for reoperation at one year postoperative shows no evidence of asymmetry, suggesting there was no statistically significant publication bias ( $P=0.189$ ; **Figure 3**). After postoperation more than two years, the reoperation rate in the HA group was 16.7% and in the IF group 50.7%, with a significant difference (OR, 0.20; 95% CI, 0.06-0.62).

Three reported postoperative urinary retention, meta-analysis of these studies showed that HA patients were more likely to develop urinary retention (OR, 2.50; 95% CI, 1.12-5.58) (**Figure 2G**).

Nine studies involving 1305 HAs and 957 IFs reported the incidence of postoperative superficial infection in the HA group was 2.9% and in the IF group 2.4%. Simultaneously, five studies reported the incidence of postoperative deep infection in the HA group was 4.2% and in the IF group 2.4%. There were no significant differences (**Table 2**).

### *Postoperative outcome assessment*

We found that the Eq-5d index score at the follow-up were generally better for the HA group, with a significant difference at 4 months (SMD, 0.23; 95% CI, 0.04-0.43) and 12 months (SMD, 0.25; 95% CI, 0.05-0.46), while there was no significant difference at 24 months ( $P=0.229$ ). Similarly the Harris hip score was significantly higher at 4 (SMD, 0.48; 95% CI, 0.28-0.68) and 12 (SMD, 0.42; 95% CI, 0.22-0.63) months in the HA group and with no significant difference at 24 months ( $P=0.095$ ).

### *Mortality*

Five studies reported mortality at a half year, but there was no difference between HA

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**Table 2.** Detailed data on comparing variables between both methods and the outcomes

Variables	No of studies	Number of patients (n/N)		OR or SMD (95% CI)	P-value	Q-test for heterogeneity (P)	I <sup>2</sup> (%)
		HA	IF				
Reoperation (1 year)	14	94/1447	404/1167	0.16 (0.09-0.29)	<0.001	<0.001	76.2
Reoperation (>2 year)	4	46/276	144/284	0.20 (0.06-0.62)	0.005	<0.001	86.1
Mortality (a half year)	5	112/744	54/423	1.27 (0.89-1.82)	0.187	0.671	0
Mortality (1 year)	10	297/1231	221/910	1.04 (0.85-1.28)	0.68	0.897	0
Mortality (>2 year)	8	137/549	119/473	1.09 (0.80-1.48)	0.579	0.931	0
Superficial infection	9	38/1305	23/957	1.46 (0.86-2.48)	0.156	0.338	11.6
Deep infection	5	22/524	13/532	1.72 (0.87-3.41)	0.12	0.553	0
Deep vein thrombosis	6	5/549	10/557	0.61 (0.24-1.51)	0.282	0.469	0
Pulmonary embolism	3	6/448	7/455	0.89 (0.31-2.57)	0.836	0.181	41.5
Haematoma	3	3/304	4/298	0.75 (0.18-3.07)	0.685	0.518	0
Pressure sores	3	8/363	10/367	0.82 (0.33-2.03)	0.661	0.5	0
Postoperative confusion	4	37/414	31/410	1.22 (0.74-2.02)	0.439	0.811	0
Pneumonia	4	63/391	43/353	1.17 (0.75-1.83)	0.495	0.651	0

HA, hemiarthroplasty; IF, internal fixation; OR, odds ratio; SMD, standard mean difference; CI, confidence interval.

(15.1%) and IF (12.8%) (OR, 1.27; 95% CI, 0.89-1.82; P=0.19). Ten reported with 2141 patients provided mortality rates 1 year after surgery. These studies did not change the overall pooled effect of HA (24.1%) compared with IF (24.3%) (OR, 1.04; 95% CI, 0.85-1.28; P=0.68) (**Figure 2H**). Eight studies reported mortality at two years, but there still was no difference in mortality after HA (25.0%) and IF (25.2%) (OR, 1.09; 95% CI, 0.80-1.48; P=0.58).

However, with regard to postoperative superficial infection, deep infection, haematoma, deep vein thrombosis, pulmonary embolism, pressure sores, pneumonia, there were no significant differences observed between both fixation methods. The results are presented in **Table 2**.

### Discussion

The treatment for displaced femoral neck fracture is operative. The most important goal of the operative treatment for femoral neck fractures is to relieve pain and to restore function. Patients are mobilised as soon as possible to regain their pre-operative walking abilities and independence. The choice of the operative method has been controversial since the early 20th century [25, 26]. Some surgeons prefer to apply the IF technique since it can reduce operation time, intraoperative blood loss and perioperative cardiovascular complications, while others believe that the HA technique can

achieve lower reoperation rate and better post-operative hip function recovery. Although increasing evidence has been supported HA as superior to IF in these fracture [7, 27], it is unclear whether HA leads to better rehabilitation in the long term. Therefore the present meta-analysis was conducted to evaluate early and late mortality, reoperation rate, major surgical complications, and function in displaced femoral neck fracture patients treated with either HA or IF.

HA may represent a heavier surgical burden for the patients of femoral neck fracture, which may lead to increased early mortality. Some studies with short-term follow-up showed that a statistically significant incremental trend in risk of death occurred after HA compared with IF [22, 28]. However, long-term results showed no difference in mortality rates between HA and IF in patients treated for displaced femoral neck fractures [8, 9, 11, 20]. Our meta-analysis suggests a similar mortality for HA and IF for treating displaced femoral neck fractures at short-term (HA 15.8% vs. IF 12.8%) and long-terms (HA 25.0% vs. IF 25.2%) results after surgery. We found no difference in patient mortality between the two treatments at short-term and long-term follow-up. One explanation is that the incidence of mortality is closely related to high age, multiple pre-existing conditions and poor mobility before the accident [29].

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The large number of patients requiring a second anaesthetic is of great concern. The reoperation rate is most important for patients with significant medical diseases. In this group of patients primary treatment failure leads to prolonged periods of pain, increased disability, and repeated operations. Fixation failure and nonunion are now being increasingly recognised as the most common reasons of reoperation treated with IF, and continued hip pain is the main cause at long-term follow-up [6, 9, 13, 22]. Furthermore, the studies with longer follow-up confirmed the markedly increased reoperation rate for those patients treated by IF with this difference persisting throughout the total follow-up period [28, 30, 31]. There is also evidence that a secondary HA after failure of IF is more likely to be painful with poor functional results and is also associated with an increased risk of complications requiring further revision than a primary HA [9, 32, 33]. Regarding reoperation, Our results revealed that HA decreased patient risk of reoperation compared with IF at one year (HA 6.5% vs. IF 34.6%) and beyond the follow-up period of two years (HA 16.7% vs. IF 50.7%).

The level of residential status, ambulation, mental status, bone density, and ASA class are patient factors that have been associated with the outcome of hip fracture management [34-36]. The Harris hip score is a widely used functional score and has been validated for patients with osteoarthritis [10, 17, 22, 37]. The Eq-5d has been recommended for patients with hip fracture and has also been found useful in those with cognitive failure [8, 24, 38]. Our meta-analysis showed that patients treated with HA had a better function recovery, higher health related quality of life, and more independence than those treated with IF in early stage, whereas we found no difference in function between the two treatments at long-term follow-up. This might be because patients can earlier engaged in simple activities after HA and rehabilitation is more rapid [39], but eventually IF patients get to the same level of function.

In terms of wound infection, our meta-analysis involving 1305 HAs and 957 IFs shown the incidence of postoperative superficial infection in the HA group was 2.9% and in the IF group 2.4%. Simultaneously, the incidence of postoperative deep infection in the HA group was 4.2%

and in the IF group 2.4%. The rate of infection in the present study was similar in the two groups, with no significant differences being observed. In our study, deep vein thrombosis was an identified complication in 1.8% of patients in the fixation group and 0.9% of patients who received a HA. The incidence of pulmonary embolism also demonstrated no differences in the two treatment groups. Other general medical complications, including haematoma, pressure sores, cerebrovascular accident, respiratory infection and urinary tract infection, affected between 1% and 16%. There were no statistically significant differences between the groups in the incidence of these complications. In addition, HA is a more complicated surgery for the treatment of displaced fractures of femoral neck in the elderly, often requiring a longer operative time and leading to a greater number of perioperative aged-related complications, such as urinary retention and cardiac failure and long-term complications, such as periprosthetic fracture and aseptic loosening compared with IF [6, 7, 31]. Although patients treated by IF had a reduced length of surgery and a tendency to a less operative blood loss, these advantages were short-lived and outweighed by the increased risk of reoperation [13]. There was also more persistent pain, malformation, stiffness and function limitation resulting from long-period bed rest in those treated by IF. In contrast, early weight bearing protocols minimize complications of prolonged inactivity after HA. Their persistent pain in the hip was inappreciable and the recovery of function excellent.

The present study suffers from some weaknesses. First, the types of IF and HA were variously applied in studies and the follow-up periods largely ranged from several months to several years. Second, not all the studies were completely randomized. Finally, many trials herein involve different generations of internal fixators, and the newer-generation implant is associated with decreased risk of implant-related fractures, which may affect the overall therapeutic effect of IF. Despite these, no significant heterogeneity was observed in most variables, indicating that the results were reliable.

Although some limitations exist, this study has its own superiority. First, the search style based on the manual and computer search ensures a

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complete inclusion of relevant studies. Second, our meta-analysis demonstrate detailed incidences of mortality, reoperation and other important complications about HA and IF for the treatment of displaced fractures of femoral neck.

In conclusion, based on the present evidence, IF for displaced femoral neck fractures is overshadowed by its high risk of reoperation and subsequent lesser cost-effectiveness. HA is a better alternative for treatment of displaced fractures of femoral neck than IF in the elderly, with a less hip pain, a better hip function, and fewer reoperations in the long run. It seems clear that most patients with displaced femoral neck fractures should be treated with arthroplasty, and further research should focus on what kind of arthroplasty to use.

### Disclosure of conflict of interest

None.

### Authors' contribution

Y.Y. and J.W. were responsible for conception and design, coordinated the study, and wrote the article. Y.Y., D.C. and L.L. were involved in the review of literature, acquisition of data, analyzed the data. Y.Y. and Q.Z. provided critical revisions. All authors read and approved the final article.

**Address correspondence to:** Dr. Yingze Zhang, Department of Orthopaedics, The 3rd Hospital, Hebei Medical University, No. 139 Ziqiang Road, Shijiazhuang 050051, P. R. China. Tel: +86-311-88603682; Fax: +86-311-87023626; E-mail: drzhangqi15@163.com

### References

- [1] Zhang Y. Clinical epidemiology of orthopedic trauma. New York: Thieme Medical Publishers; 2012.
- [2] van Vugt AB, Oosterwijk WM and Goris RJ. Osteosynthesis versus endoprosthesis in the treatment of unstable intracapsular hip fractures in the elderly. A randomised clinical trial. *Arch Orthop Trauma Surg* 1993; 113: 39-45.
- [3] Hui AC, Anderson GH, Choudhry R, Boyle J and Gregg PJ. Internal fixation or hemiarthroplasty for undisplaced fractures of the femoral neck in octogenarians. *J Bone Joint Surg Br* 1994; 76: 891-894.
- [4] Hunter GA. A further comparison of the use of internal fixation and prosthetic replacement for fresh fractures of the neck of the femur. *Br J Surg* 1974; 61: 382-384.
- [5] Young Y, German P, Brant L, Kenzora J and Magaziner J. The predictors of surgical procedure and the effects on functional recovery in elderly with subcapital fractures. *J Gerontol A Biol Sci Med Sci* 1996; 51: M158-164.
- [6] Sikorski JM and Barrington R. Internal fixation versus hemiarthroplasty for the displaced subcapital fracture of the femur. A prospective randomised study. *J Bone Joint Surg Br* 1981; 63-b: 357-361.
- [7] Parker MJ, Khan RJ, Crawford J and Pryor GA. Hemiarthroplasty versus internal fixation for displaced intracapsular hip fractures in the elderly. A randomised trial of 455 patients. *J Bone Joint Surg Br* 2002; 84: 1150-1155.
- [8] Keating JF, Grant A, Masson M, Scott NW and Forbes JF. Randomized comparison of reduction and fixation, bipolar hemiarthroplasty, and total hip arthroplasty. Treatment of displaced intracapsular hip fractures in healthy older patients. *J Bone Joint Surg Am* 2006; 88: 249-260.
- [9] Frihagen F, Nordsletten L and Madsen JE. Hemiarthroplasty or internal fixation for intracapsular displaced femoral neck fractures: randomised controlled trial. *BMJ* 2007; 335: 1251-1254.
- [10] Ravikumar KJ and Marsh G. Internal fixation versus hemiarthroplasty versus total hip arthroplasty for displaced subcapital fractures of femur-13 year results of a prospective randomised study. *Injury* 2000; 31: 793-797.
- [11] Bjorgul K and Reikeras O. Hemiarthroplasty in worst cases is better than internal fixation in best cases of displaced femoral neck fractures: a prospective study of 683 patients treated with hemiarthroplasty or internal fixation. *Acta Orthop* 2006; 77: 368-374.
- [12] Hedbeck CJ, Inngul C, Blomfeldt R, Ponzer S, Tornkvist H and Enocson A. Internal fixation versus cemented hemiarthroplasty for displaced femoral neck fractures in patients with severe cognitive dysfunction: a randomized controlled trial. *J Orthop Trauma* 2013; 27: 690-695.
- [13] Parker MJ. Hemiarthroplasty versus internal fixation for displaced intracapsular fractures of the hip in elderly men: a pilot randomised trial. *Bone Joint J* 2015; 97-b: 992-996.
- [14] Gao H, Liu Z, Xing D and Gong M. Which is the best alternative for displaced femoral neck fractures in the elderly?: A meta-analysis. *Clin Orthop Relat Res* 2012; 470: 1782-1791.
- [15] Zhao Y, Fu D, Chen K, Li G, Cai Z, Shi Y and Yin X. Outcome of hemiarthroplasty and total hip replacement for active elderly patients with displaced femoral neck fractures: a meta-analysis of 8 randomized clinical trials. *PLoS One* 2014; 9: e98071.
- [16] Oremus M, Wolfson C, Perrault A, Demers L, Momoli F and Moride Y. Interrater reliability of



## Comparison of HA versus IF in treatment of DFNF

- the modified Jadad quality scale for systematic reviews of Alzheimer's disease drug trials. *Dement Geriatr Cogn Disord* 2001; 12: 232-236.
- [17] Soderman P and Malchau H. Is the Harris hip score system useful to study the outcome of total hip replacement? *Clin Orthop Relat Res* 2001; 189-197.
- [18] EuroQol Group. EuroQol—a new facility for the measurement of health-related quality of life. *Health Policy* 1990; 16: 199-208.
- [19] Lau J, Ioannidis JP and Schmid CH. Quantitative synthesis in systematic reviews. *Ann Intern Med* 1997; 127: 820-826.
- [20] Soreide O, Molster A and Raugstad TS. Internal fixation versus primary prosthetic replacement in acute femoral neck fractures: a prospective, randomized clinical study. *Br J Surg* 1979; 66: 56-60.
- [21] Roden M, Schon M and Fredin H. Treatment of displaced femoral neck fractures: a randomized minimum 5-year follow-up study of screws and bipolar hemiprostheses in 100 patients. *Acta Orthop Scand* 2003; 74: 42-44.
- [22] Davison JN, Calder SJ, Anderson GH, Ward G, Jagger C, Harper WM and Gregg PJ. Treatment for displaced intracapsular fracture of the proximal femur. A prospective, randomised trial in patients aged 65 to 79 years. *J Bone Joint Surg Br* 2001; 83: 206-212.
- [23] Puolakka TJ, Laine HJ, Tarvainen T and Aho H. Thompson hemiarthroplasty is superior to Ull-eval screws in treating displaced femoral neck fractures in patients over 75 years. A prospective randomized study with two-year follow-up. *Ann Chir Gynaecol* 2001; 90: 225-228.
- [24] Blomfeldt R, Tornkvist H, Ponzer S, Soderqvist A and Tidermark J. Internal fixation versus hemiarthroplasty for displaced fractures of the femoral neck in elderly patients with severe cognitive impairment. *J Bone Joint Surg Br* 2005; 87: 523-529.
- [25] Sim FH. Displaced femoral neck fractures: the rationale for primary total hip replacement. *Hip* 1983; 51-61.
- [26] Dorr L. Treatment of hip fractures in elderly and senile patients. *Orthop Clin North Am* 1981; 12: 153-163.
- [27] Heetveld MJ, Rogmark C, Frihagen F and Keating J. Internal fixation versus arthroplasty for displaced femoral neck fractures: what is the evidence? *J Orthop Trauma* 2009; 23: 395-402.
- [28] Leonardsson O, Sernbo I, Carlsson A, Akesson K and Rogmark C. Long-term follow-up of replacement compared with internal fixation for displaced femoral neck fractures: results at ten years in a randomised study of 450 patients. *J Bone Joint Surg Br* 2010; 92: 406-412.
- [29] Kopp L, Edelmann K, Obruba P, Prochazka B, Blstakova K and Dzupa V. [Mortality risk factors in the elderly with proximal femoral fracture treated surgically]. *Acta Chir Orthop Traumatol Cech* 2009; 76: 41-46.
- [30] Parker MJ, Pryor G and Gurusamy K. Hemiarthroplasty versus internal fixation for displaced intracapsular hip fractures: a long-term follow-up of a randomised trial. *Injury* 2010; 41: 370-373.
- [31] Stoen RO, Lofthus CM, Nordsletten L, Madsen JE and Frihagen F. Randomized trial of hemiarthroplasty versus internal fixation for femoral neck fractures: no differences at 6 years. *Clin Orthop Relat Res* 2014; 472: 360-367.
- [32] Roberts C and Parker MJ. Austin-Moore hemiarthroplasty for failed osteosynthesis of intracapsular proximal femoral fractures. *Injury* 2002; 33: 423-426.
- [33] McKinley J and Robinson C. Treatment of displaced intracapsular hip fractures with total hip arthroplasty: comparison of primary arthroplasty with early salvage arthroplasty after failed internal fixation. *J Bone Joint Surg* 2002; 84: 2010-2015.
- [34] Schep NW, Heintjes RJ, Martens EP, van Dortmont LM and van Vugt AB. Retrospective analysis of factors influencing the operative result after percutaneous osteosynthesis of intracapsular femoral neck fractures. *Injury* 2004; 35: 1003-1009.
- [35] Toh EM, Sahni V, Acharya A and Denton JS. Management of intracapsular femoral neck fractures in the elderly; is it time to rethink our strategy? *Injury* 2004; 35: 125-129.
- [36] Holt EM, Evans RA, Hindley CJ and Metcalfe JW. 1000 femoral neck fractures: the effect of pre-injury mobility and surgical experience on outcome. *Injury* 1994; 25: 91-95.
- [37] Hoeksma HL, Van Den Ende CH, Runday HK, Heering A and Breedveld FC. Comparison of the responsiveness of the Harris Hip Score with generic measures for hip function in osteoarthritis of the hip. *Ann Rheum Dis* 2003; 62: 935-938.
- [38] Tidermark J and Bergstrom G. Responsiveness of the EuroQol (EQ-5D) and the Nottingham Health Profile (NHP) in elderly patients with femoral neck fractures. *Qual Life Res* 2007; 16: 321-330.
- [39] Kayali C, Agus H, Ozluk S and Sanli C. Treatment for unstable intertrochanteric fractures in elderly patients: internal fixation versus cone hemiarthroplasty. *J Orthop Surg (Hong Kong)* 2006; 14: 240-244.