

Original article

Has the risk of dislocation after total hip arthroplasty performed for displaced femoral neck fracture improved with modern implants?



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ARTICLE INFO

Article history:

Received 1 May 2017

Received in revised form 31 August 2017

Accepted 7 September 2017

Available online 8 September 2017

Keywords:

Femoral neck fracture

Total hip arthroplasty

Dislocation

Acetabular cup positioning

ABSTRACT

Background: Displaced femoral neck fractures (DFNF) in the elderly can be treated with hemiarthroplasty or total hip arthroplasty (THA). One concern with utilizing THA in this setting is post-operative dislocation. The purposes of this study were to determine the incidence of hip dislocation following THA for DFNF and to identify risk factors for dislocation.

Methods: The charts of 66 posterior-approach THA cases performed for DFNF with mean post-operative follow-up of 4.4 years were retrospectively reviewed. Pre-operative patient demographic data and intra-operative clinical data were recorded including age, race, gender, height, weight, body mass index (BMI), femoral head diameter, acetabular cup diameter, use of an elevated liner, and cementing of femoral component. For patients with available post-operative pelvis radiographs, acetabular cup inclination and version angles were also calculated.

Results: Four dislocation (4/66, 6%) events occurred at an average of 51 days after surgery. No specific risk factors for dislocation were identified but the use of a cemented femoral stem did approach significance ($p = 0.06$). 47% of the acetabular cups were located outside of the Lewinnek safe zone. Although the dislocation rate of THAs with acetabular cups outside of the safe zone was higher than the dislocation rate for THAs with cups in the safe zone (12.5% vs 0%), placement of acetabular cups outside of the safe zone was not a risk factor for dislocation.

Conclusions: Posterior THA with proper cup positioning and meticulous soft tissue repair is an effective treatment option for DFNF with low dislocation risk.

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1. Introduction

As the population in the United States ages, the annual incidence of hip fractures is projected to exceed 500,000 cases by the year 2040, with an annual cost of nearly \$16 billion.¹ In cases of displaced femoral neck fractures (DFNF), three surgical options are available: open reduction and internal fixation (ORIF), hemiarthroplasty, and total hip arthroplasty (THA). Arthroplasty is preferred for older patients with fragility fractures of the femoral neck, diminished healing potential, concurrent arthritic disease, and preference for early weight bearing. Hemiarthroplasty is commonly offered for displaced femoral neck fractures in elderly

patients, with 85% of surgeons choosing this option given its decreased procedural time, blood loss, and perceived reduced dislocation rate.² Total hip arthroplasty (THA) is preferred in active, elderly patients, particularly in patients with pre-existing osteoarthritis of the injured hip.³

There is ongoing debate concerning the superiority of outcomes following hemiarthroplasty versus THA for displaced femoral neck fractures. Dislocation is a relevant issue given that many patients who sustain femoral neck fractures have some degree of cognitive impairment, limited mobility, and/or gait instability. Furthermore, soft tissue tensioning in the setting of THA for femoral neck fracture is not as reliable nor as reproducible as in the setting of THA for osteoarthritis. Randomized clinical trials comparing outcomes after hemiarthroplasty and THA for displaced femoral neck fractures have reported dislocation rates varying from 0 to 20%.⁴ Although THA has traditionally been purported to have a higher dislocation risk, a recent meta-analysis of eight Level 1 studies comparing outcomes for THA versus hemiarthroplasty

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found no significant difference in the incidence of dislocation.⁴ Furthermore, THA has been shown to have better functional outcomes and lower rates of revision surgery than hemiarthroplasty where there is concern for future acetabular degeneration secondary to wear and bone loss from the prosthetic femoral head.^{5–8}

The purposes of this study were to analyze the rate of post-operative dislocation following THA performed utilizing a posterior approach with soft tissue repair for displaced femoral neck fractures, and to identify risk factors for dislocation.

2. Materials and methods

After obtaining approval from our Institutional Review Board, we identified 103 consecutive cases of THA for a DFNF between February 2001 and March 2015. All surgical procedures were performed by six orthopedic surgeons with fellowship training in adult reconstruction. Exclusion criteria included patients with prior surgery done on the injured hip, patients that underwent an anterolateral surgical approach, had less than six months of follow-up, died prior to six-month follow-up, or patients that died after six-months post-operatively but were lost to follow-up, Fig. 1. The remaining 66 subjects comprised our study cohort. All THAs were performed via a posterior approach with a posterior soft tissue repair of the capsule and short external rotator muscles. Cementless and cemented components were included.

The cohort was divided into patients that experienced a dislocation and those that did not have a dislocation. Pre-operative patient demographic data and intra-operative clinical data were recorded including age, race, gender, height, weight, body mass index (BMI), femoral head diameter, acetabular cup diameter, use of an elevated liner, and cementing of femoral component.

A separate analysis was performed to determine the risk of dislocation with respect to cup abduction and anteversion. This analysis required a digital post-operative anteroposterior (AP) pelvic radiograph; cup inclination and version angles were calculated from the AP film using Martell Hip Analysis Suite Version 8.0.4.1 (Martell HAS™, Chicago, IL).^{9,10} 34/66 patients had

adequate AP pelvic x-rays to determine cup inclination and version angles. Two unbiased authors, blinded to patient identifiers and clinical outcome, separately performed all measurements with an inter-observer reliability of 0.962 for anteversion and 0.977 for abduction by intra-class correlation coefficient. Since HAS is unable to determine the sign of the version angle, cross-table lateral radiographs were used to determine if the cup was anteverted or retroverted. Using Lewinnek's safe zone for cup positioning (5–25° anteversion, 30–50° abduction), we then determined if the cup was in or out of the safe zone, and using cox regression analysis, determined the risk of dislocation based on cup position.

SPSS (Version 2.0, IBM, Chicago IL) was used for all statistical calculations. Descriptive statistics included mean $\pm$ standard deviation for continuous variables and frequencies and percentages for categorical variables. Two-tailed *t*-tests were used to evaluate the differences between continuous variables. Chi-square and Fisher's exact test were used to determine differences between categorical variables. Cox regression analysis was used to evaluate factors associated with dislocation after THA. Age, sex, BMI, race, femoral head diameter, acetabular cup diameter, femoral head type, use of cement, liner type, date of surgery, and history of previous surgery were tested as independent factors in the model. The associations were presented as hazards ratios (HRs) with 95% confidence intervals. Using the Wald test, these associations were considered significant if $p < 0.05$. All tests were two-sided.

3. Results

At a mean follow up of 4.4 years (range, 8 months–10.9 years), 4 of the 66 THAs dislocated (6%) at an average of 1.7 months (51 days) after surgery. All dislocations occurred within 6 months of surgery (range, 14–147 days). Patient characteristics of gender, age, height, and BMI had no significant impact on risk for dislocation. See Table 1 for differences in baseline characteristics between patients that experienced a dislocation event and those that were not. Surgical factors of femoral head size, cup diameter, liner elevation, and use of acetabular screws were not significant risk

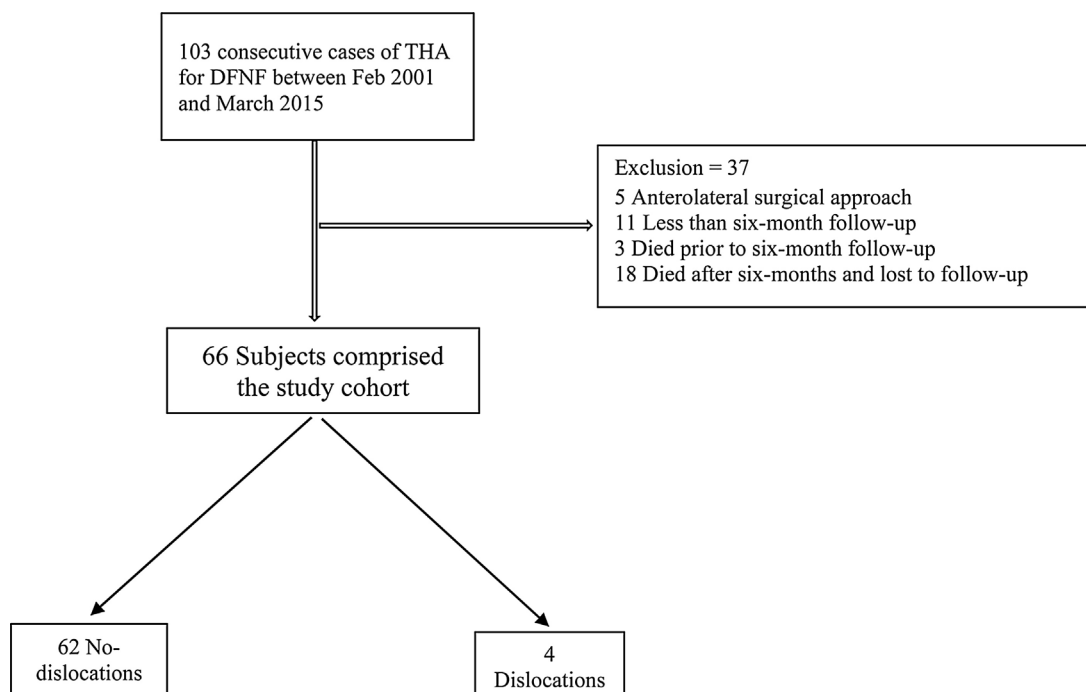


Fig. 1. Flow chart of subjects for inclusion, exclusion and final analysis.

Table 1
Baseline Patient Demographics.

	All (n = 66)	Dislocators (n = 4)	Non-dislocators (n = 62)	p-value
Age, mean (SD)	73.3 (9.7)	75.2	73.2	0.73
Gender				0.569
Female	52	4	48	
Male	14	0	14	
Race ^a				0.554
White	29	4	25	
Non-white	9	0	9	
BMI, mean (SD) ^b	25.1 (5.2)	22.2	25.2 (5.3)	0.599
Height, mean (SD) ^c	165.1 (8.1)	149.9	165.6 (7.7)	0.035

^a Race was unknown in 20 cases.^b BMI data was unknown in 27 cases; SD unable to be calculated for dislocators since there was only 1 dislocator who had BMI data.^c Height data was unknown in 24 cases; SD unable to be calculated for dislocators since there was only 1 dislocator who had height data.

factors for dislocation. The use of cement around the femoral component approached statistical significance as a risk factor for dislocation (HR 9.53; 95% CI 0.991–91; $p=0.06$). The type of anesthesia used, general or neuraxial-spinal, was not a significant risk factor for dislocation. See Table 2 for the list of potential risk factors for dislocation analyzed.

In a sub-group analysis, 34 patients (51.5%) had x-rays to evaluate for cup anteversion and abduction angles. Eighteen of these 34 patients (53%) had cups that were placed inside the Lewinnek safe zone, with none of these patients suffering dislocations. Two of the 16 patients (12.5%) whose cups were placed outside the safe zone dislocated. Placement of the

acetabular component outside the Lewinnek safe zone (5–25° anteversion, 30–50° abduction) was not a significant factor in the risk for eventual dislocation (HR 0.014; 95% CI 0–1230.3; $p=0.462$).

4. Discussion

Instability remains a complication following a total hip arthroplasty performed in the setting of an acute displaced femoral neck fracture (DFNF). Controversy exists regarding the effect of surgical approach on dislocation rate. Proponents of the anterior approach cite lower dislocation rates and a less relevant position of risk, while those who utilize the posterior approach have adopted a meticulous posterior capsule repair with abductor complex sparing to reduce the risk of dislocation. Regardless of approach, there is a higher rate of dislocation after THA performed for DFNF compared to THA performed for treatment of osteoarthritis.^{11,12} In this study we found a dislocation rate of 6%, a lower rate than that reported in the literature.^{13–17} Although earlier studies have reported dislocation rates as high as 20%,^{8,18–20} these studies included patients with dementia^{8,19} small femoral head sizes,¹⁴ and cases where the posterior capsule was not repaired.¹⁴ These factors are known to be risk factors for dislocation. More recent studies however, have found dislocation rates ranging from 0 to 14% following posterior approach THA.^{13–15,21}

Patient factors can contribute to the risk for dislocation following THA. Some studies report that female gender is a risk factor for instability following THA.^{11,12,22} This finding may be related to increased preoperative range of motion and greater tissue laxity. However, other authors have found no increased risk for females.^{23,24} Age and BMI may have a role as risk factors for instability. This current study found that age, gender, BMI and height were not significant risk factors for dislocation after THA for DFNF; however, our study size may not be large enough to answer that question. These results are comparable to a large study by Enocson et al. which similarly found that age and gender were not significant risk factors for dislocation.¹⁵

Surgical factors that increase the risk for posterior THA instability have been studied extensively. The most important factors are small femoral head diameter and failure to repair the posterior capsule.^{15,25,26} In the current study, femoral head diameter was not a significant risk factor for dislocation. Two of the dislocations were 36 mm heads, one utilized a 32 mm head and the other a 28 mm head. With many surgeons opting to use larger-diameter heads in light of recent published literature, there are very few cases with smaller-diameter femoral heads (28 mm or less). This study only had 13 cases out of 66 (19.7%) where a 28 mm or 22 mm femoral head was used. This small cohort size qualifies

Table 2
Univariate cox regression to evaluate factors associated with dislocation.

Explanatory	n	Dislocation rate (%)	Hazards Ratio (95% CI)	p-value
Age				
<75 years	28	7.4		
≥75 years	30	6.7	0.865 (0.122–6.143)	0.885
Gender				
Female	45	8.9		
Male	13	0.0	0.034 (0–917.4)	0.516
Race				
White	29	13.8		
Non-white	9	0.0	0.033 (0–758.1)	0.507
BMI				
<25 kg/m ²	19	5.3		
≥25 kg/m ²	12	0.0	0.022 (0–395727)	0.656
Femoral head diameter				
≤28 mm	10	10		
≥32 mm	47	6.5	0.660 (0.07–6.34)	0.719
Cup Diameter				
≤50 mm	21	4.8		
≥52 mm	37	8.3	1.79 (0.186–17.23)	0.614
Elevated liner				
No	30	6.7		
Yes	26	8.0	1.23 (0.174–8.73)	0.836
Cemented stem				
No	42	2.4		
Yes	16	18.8	8.9 (0.926–86)	0.06
Within safe zone				
No	16	12.5		
Yes	18	0.0	0.014 (0–1230.3)	0.462

our results that head size was not a risk factor for instability. Lee et al. also found no significant association between small femoral head size (22 mm compared to all other sizes) and dislocation risk.¹³

We found that other surgical factors had no influence on the risk for dislocation, including femoral head type, acetabular cup diameter, use of acetabular screws, and type of anesthesia. The use of a cemented femoral component approached but did not achieve statistical significance as a risk factor for dislocation with a p-value of 0.06. In determining the need for cement, an assessment of the quality of the proximal femoral bone stock was made at the time of surgery. If bone stock was found to be deficient or severely osteoporotic, then cement was more likely to be utilized with the ultimate decision of whether or not to cement the femoral stem being made at the surgeon's discretion.

This study has its limitations, including the relatively small sample size and incomplete data points with respect to some variables. Femoral neck fracture is an injury seen most commonly in the elderly population and one-year mortality following hip fracture treatment is relatively high making it difficult to achieve long-term follow up in a single cohort. In this study, many patients were lost to follow up or had died prior to six months follow-up and were therefore, unable to be included in the study. Using a minimum of only six months post-operative follow up, later dislocations may not be missed. Although dislocations may occur six months after the index procedure, previous studies have shown that most dislocations occur within the first three to six months after surgery. Also we have only 6 patients with less than a year follow-up. In our study, all four dislocations occurred well within the first six months post-operatively. Another limitation to the study is the lack of inclusion of some surgical factors that may influence dislocation rate, including soft tissue tensioning, leg-length inequality, and the quality of the hip abductor complex.²⁷

Although the current study suggests that the risk of dislocation following posterior THA in the setting of acute DFNF may be lower than previously thought, the risk is still significantly higher than that for primary elective THA performed in the setting of osteoarthritis. The use of large femoral heads, meticulous capsular repair, restoration of offset, and use of elevated liners have been shown to significantly reduce the likelihood of dislocation to as low as 2%.²¹ Proper patient selection, close attention to acetabular cup position, and a diligent posterior soft tissue repair are essential to minimizing this risk.

Compliance with ethical standards

No funding was received for this study. Jeffrey Geller reports personal fees from Smith and Nephew and Orthosensor for consultancy outside the submitted work. Jeffrey Geller also reports research support from Smith and Nephew, Orthosensor, and the Orthopaedic Research and Education Foundation outside the submitted work. Roshan Shah reports personal fees from Link Orthopaedics. No conflict of interest is reported by any of the other authors. No conflict of interest with the material presented in this manuscript is reported by any authors. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required. The study has been approved by our internal IRB under protocol AAAI0424.

Conflict of interest

None.

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