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Treatment of femoral neck fractures in patients 45–64 years of age

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ABSTRACT

Introduction: Young patients with femoral neck fractures are optimally treated with reduction and stable fixation, while patients over the age of sixty-five are often treated with arthroplasty. This study analyzes in-hospital outcomes associated with total hip arthroplasty, hip hemiarthroplasty and internal fixation for treatment of femoral neck fractures in patients aged 45–64.

Methods: Records of patients between the ages of 45–64, from 2002 to 2014, sustaining femoral neck fractures and treated with internal fixation, hip hemiarthroplasty or total hip arthroplasty were obtained from the Nationwide Inpatient Sample (NIS). Examined variables were age, sex and Charlson Comorbidity Index (CCI). Outcome measures included hospital length of stay (LOS), complications, and inpatient hospitalization charge.

Results: From 2002–2014 74,678 femoral neck fractures were available for analysis. THA use increased from 5.3% of operatively managed fractures in 2002 to 22.3% of operatively managed fractures in 2014 ($p < 0.0001$). Patients undergoing THA had higher hospital cost, higher in hospital complication rates and longer length of stay than patients undergoing internal fixation ($p < 0.0001$). The in-hospital mortality for patients undergoing a hip hemiarthroplasty was higher (1.2%) than either total hip arthroplasty (0.2%) or internal fixation (0.5%) ($P = 0.007$).

Conclusion: This study demonstrates that the use of total hip arthroplasty in treatment of femoral neck fractures in patients from the age of 45–64 increased 4.2-fold over the study period. This treatment is associated with increased hospital cost, length of stay and complications. Additionally, as age increased in our study population, there was a stepwise increase in the use of arthroplasty, and it appears that hemiarthroplasty is being used with a different patient population.

Introduction

Femoral neck fractures are often challenging injuries to treat possibly leading to permanent disability, particularly debilitating for young patients [1–3]. These fractures are typically treated with either open or closed reduction and internal fixation in young patients in order to preserve the native hip and optimize outcomes [2–4]. However, given the high shear forces, challenging anatomy, and tenuous blood supply surrounding these fractures, complications such as nonunion, avascular necrosis, and reoperation are common [1,5,6]. Because of these high rates of post-operative complications, several authors have sought to determine the optimal method of fixation of these fractures, with no consensus available in the literature [6–10].

In elderly populations, the standard of care for displaced femoral neck fractures is arthroplasty [11–13]. With newer implants, extended life expectancy, and higher patient activity levels, significant effort has been put into determining whether hemiarthroplasty or total arthroplasty (THA) provide the best outcome for these patients over 65 [12–14]. While this topic remains under debate, it is important that patient factors, including preoperative functional status and medical comorbidities, be carefully considered when deciding on treatment of intracapsular hip fractures in the elderly [12–14]. Beyond primary fracture treatment, THA also has further utility as a revision option

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when treating nonunion or avascular necrosis following internal fixation of femoral neck fractures in younger patients [15–17]. Although this revision procedure typically provides good short-term results, some studies report a higher risk of dislocation and periprosthetic infection when compared to primary elective THA [16,17].

Traditionally, total hip arthroplasty and hemiarthroplasty have been primarily offered to older patients in the setting of femoral neck fractures given the concern for long term hardware complications and reoperations. Recently, more literature has become available regarding the use of THA in patients under the age of 50 [18–20]. Given these new promising results, there has been increased optimism regarding the long term durability of THA for a variety of indications in younger populations leading to more liberal use in the "young" patient [18,20].

As experience has grown with use of arthroplasty in the younger patient with arthritis, the question whether the middle-aged patients (ages 45–64) should undergo fixation or arthroplasty has been posed. The literature demonstrates that the optimal treatment of young patients with displaced femoral neck fractures is internal fixation, and the optimal treatment of elderly patients with displaced femoral neck fractures is some form of arthroplasty, while the frequency and outcome of arthroplasty (both total arthroplasty and hemiarthroplasty) in this cohort (45–64 years old) is unknown.

Our study seeks to determine the rate of total hip arthroplasty, hemiarthroplasty and internal fixation used in femoral neck fracture patients from the ages of 45 to 64, using the Nationwide Inpatient Sample database. Given the increasing popularity of total hip arthroplasty to treat femoral neck fractures, and the increasing evidence to support the long-term viability of arthroplasties in young patient populations, we hypothesize that the rate of total hip arthroplasty to treat femoral neck fractures in this patient population is increasing over time. Additionally, we seek to examine the length of stay, in-hospital complication rate, and hospital cost associated with each of these treatment modalities.

Methods

Data collection

The Nationwide Inpatient Sample (NIS) database was utilized to access U.S. inpatient data from 2002 to 2014. The NIS represents a 20-percent stratified sample of all discharges at all of the hospitals in the 46 participating states. This design and the large sample size (over 7 million annual stays) allows for results to be generalized to a national population. Patients with femoral neck fractures (OTA Classification: 31-B1, 31-B2, 31-B3) from the ages of 45–64 undergoing open reduction and internal fixation, hemiarthroplasty or total hip arthroplasty were included. Patients were identified using International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9 CM) diagnosis codes (codes 820.00, 820.01, 820.02, 820.09, Table 1). Examined variables included patient age, sex, hospital location (rural vs. urban, as defined by NIS sampling), and Charlson Comorbidity Index (CCI). Outcomes queried were hospital length of stay (LOS), total inpatient hospitalization charge, and in-hospital complication rates. Surgical treatment was defined by ICD procedure codes as internal fixation (codes 79.15, 79.35), partial hip replacement (code 81.52) and total hip replacement (code 81.51) (Table 1).

Table 1
Included diagnoses and procedures, by International Classification of Disease, 9th edition, Clinical Modification (ICD-9-CM) code.

ICD-9 CM	Diagnosis/Procedure Description
Diagnosis	
820	Closed fracture of intracapsular section of neck of femur, unspecified
820.01	Closed fractue of epiphysis (separation) (upper) of neck of femur
820.02	Closed fracture of midvervicl section of neck of femur
820.09	Other closed transcervical fracture of neck of femur
Procedure	
79.15	Closed reduction of fracture with internal fixation, femur
79.35	Open reduction of fracture with internal fixation, femur
81.51	Total hip replacement
81.52	Partial hip replacement

Statistics

Total annual case numbers were estimated by the Healthcare Cost and Utilization (HCUP) national discharge weights. Multivariable logistic regression adjusting for surgery type, age, gender, Charlson Comorbidity Index and year of admission was used to calculate demographic variables associated with surgical intervention, length of stay, and total charges. Multivariable linear regression was used to determine variables associated with mortality and in-hospital complications. Standard error was calculated for all variables. Odds ratios and 95% confidence limits were calculated for logistic regression variables. All statistical analyses were performed utilizing SAS statistical software v.9.4 (SAS Institute, Inc. Cary, NC). Statistical significance was set at $p < 0.05$ *a priori*.

Results

Demographics

Over the 13-year period from 2002 to 2014, 78,645 admissions for femoral neck fractures were identified, of which 74,678 (79.2%) were managed operatively in patients aged 45–64. Overall, 44.6% of patients in this cohort were treated with internal fixation, 12.6% were treated with total hip arthroplasty and 42.8% were treated with hemiarthroplasty.

The mean age of surgically treated femoral neck fractures was 57.4 years old and 59.1% of patients treated surgically were female (Table 2). The mean CCI for patients treated with internal fixation, hemiarthroplasty or arthroplasty was 1.08. Over the 12-year study period, THA use increased from 267 in 2002 (5.3% of operatively managed fractures) to 1395 (22.3% of operatively managed fractures) in 2014 ($p < 0.0001$) (Fig. 1). Over the 12-year study period, the percentage of all femoral neck fractures that occurred in this 45–64 year-old group increased significantly from 7.4% in 2002 to 11.2% in 2014, as compared to the total number of hip fractures occurring in all ages ($p < 0.0001$) (Fig. 2). While the total number of femoral neck fractures treated with internal fixation increased from 2002 (2594) to 2014 (2605), the overall percentage of femoral neck fractures treated with internal fixation actually declined from 51.6% in 2002, to 41.6% in 2014 ($p < 0.001$) (Fig. 1). There was no significant change in the percentage of femoral neck fractures treated with hemiarthroplasty over the course of this study ($p = 0.556$) (Fig. 1).

Arthroplasty patients were older than internal fixation patients, 58.2 years old vs 56.1 years old ($p < 0.0001$). When subdivided into 5-year age brackets (45–49, 50–54, 55–59, 60–64) there was a stepwise increase in the rate of total hip arthroplasty for femoral neck fracture treatment ($p < 0.0001$) (Table 3). Female patients were more likely to undergo THA rather than internal fixation (65.4% vs 55.4%) ($p = 0.0004$). Patients undergoing THA a similar CCI than those undergoing internal fixation (0.91 vs 0.84) ($p < 0.9153$) (Table 4). However, patients undergoing hemiarthroplasty had a higher CCI (1.37) than ORIF patients (0.84) ($p < 0.001$) or total hip replacement patients (0.91) ($p < 0.001$) (Table 4).

Table 2
Demographics of all surgically treated patients with femoral neck fractures in this age group.

Demographic Variable	ORIF (+/- SE)	THA (+/- SE)	PHA (+/- SE)	Overall (+/- SE)
Percent of Patients	44.6% (0.5%)	12.6% (0.3%)	42.8% (0.5%)	100%
Age	56 (0.06)	58.2 (0.1)	58.5 (0.6)	57.4 (0.04)
Female Sex	55.4% (0.6%)	65.4% (1%)	61% (0.6%)	59.1% (0.4%)
CCI	0.84 (0.02)	0.91 (0.03)	1.37 (0.02)	1.08 (0.01)

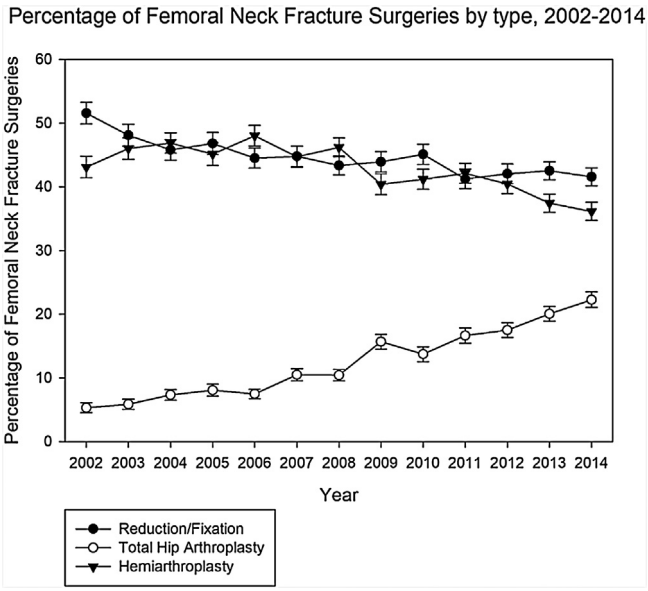

Fig. 1. Rates of internal fixation and total hip arthroplasty in patients with femoral neck fractures from 2002 to 2014.

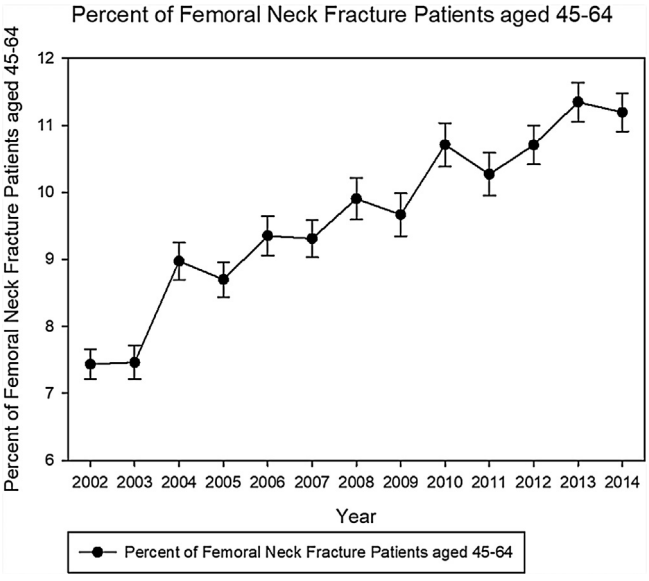

Fig. 2. Percentage of total femoral neck fractures in patients aged 45–64 from 2002 to 2014.

In-hospital outcomes

The complication rate for patients undergoing surgical treatment with internal fixation, hemiarthroplasty or total hip arthroplasty for femoral neck fractures was 10.3% and the average length of stay was 6.4 days. The average total hospital cost for patients treated surgically with internal fixation or total hip arthroplasty was $54,110, while the in-hospital mortality rate was 1.2% (Table 4).

Patients undergoing THA had an average hospital cost of $72,840 while patients undergoing internal fixation had an average hospital cost of $45,723 ($p < 0.0001$) (Table 4). The average length of stay for patients undergoing total hip arthroplasty was 6.6 days, significantly higher than the average length of stay of 5.6 days for patients undergoing internal fixation ($p < 0.0001$) (Table 4). When corrected for CCI, the in-hospital complication rate for total hip arthroplasty was 14.1% while the average in- hospital complication rate for internal fixation was 7.6% ($p < 0.0001$) (Table 4) (Table 5).

When comparing patients undergoing total hip arthroplasty and hemiarthroplasty, hemiarthroplasty patients on average had lower costs ($57,034 vs $72,840; $p < 0.001$), higher mortality rates (1.2% vs 0.2%; $p = 0.0072$) and longer lengths of stay (7.2 vs 6.6; $p < 0.001$). However, complication rates between the two groups were not significantly different ($p = 0.06$) (Table 4). When comparing patients undergoing internal fixation and hemiarthroplasty, internal fixation patients had a lower complication rate (7.9% vs 12.3%; p, 0.001), lower total charges ($45,723 vs $57,034; $p < 0.001$), shorter lengths of stay (5.6 vs 7.2; $p < 0.001$) and a lower mortality rate (0.5% vs 1.2%; $p = 0.006$) (Table 4).

Discussion

Femoral neck fractures are often challenging injuries for orthopedic surgeons to treat, and may cause long term disability for the patients who sustain them. While it has been established that the optimal treatment for young patients sustaining these fractures is internal fixation, no consensus exists on the timing of fixation for these fractures, the need for open versus closed reduction, or the ideal surgical implants to stabilize the fractures [6–9,21]. Radiographically excellent reduction, and stable fixation of these fractures, is however agreed upon as a necessity [5]. Even with optimal radiographic results, reoperation rates as high as 20% can be expected in young patients, for complications such as nonunion, avascular necrosis, hardware failure, or post-traumatic arthritis [1,5].

In older patients with displaced femoral neck fractures, who often have poor bone stock and high rates of failure of fixation, internal fixation options are usually avoided, and either hemiarthroplasty or THA is the treatment of choice [11–14,22]. The choice of hemiarthroplasty versus THA in patients over the age of 65 with displaced femoral neck fractures is still debated, but some form of arthroplasty is usually the preferred treatment modality [13,14]. Recently, there is increasing evidence that active, elderly patients with displaced femoral neck fractures may benefit more from total hip arthroplasty as opposed to hemiarthroplasty [23,24]. This does mirror our results in this population, as older patients were more likely to receive a total hip arthroplasty in this cohort. Additionally, our findings demonstrate that patients undergoing hemiarthroplasty in this age group are more sick, as identified by the Charlson Comorbidity Index, and subsequently are more likely to experience in hospital mortality. While arthroplasty is often used as a revision procedure for failed internal fixation of femoral neck fractures where there is significant femoral head bone loss or acetabular erosion, it is

Table 3
Total number, and percentage of patients in each 5-year age group undergoing total hip arthroplasty for femoral neck fracture.

Age Group	Number of Patients	Standard Error	Percent that received arthroplasty	Standard Error
45-49	5537	185	8.90%	0.5
50-54	9270	259	17.90%	0.9
55-59	12,641	310	22.10%	0.9
60-64	15,268	319	29.40%	0.9

Table 4
Length of stay, hospital cost, complication rate and mortality rate between ORIF, THA and hemiarthroplasty groups.

Demographic Variable	ORIF (+/- SE)	THA (+/- SE)	PHA (+/- SE)	Overall (+/- SE)
Complication Rate	7.9% (0.3%)	13.4% (0.8%)	12.3% (0.4%)	10.3% (0.2%)
Length of Stay	5.6 (0.09)	6.6 (0.12)	7.22 (0.1)	6.4 (0.07)
Total Charges	$45723 ($1065)	$72840 ($1638)	$57034 ($910)	$54110 ($792)
Mortality Rate	0.5% (0.09%)	0.2% (0.1%)	1.2% (0.1%)	0.8% (0.07%)

Table 5
Summary of recorded complications and rates amongst ORIF, THA and hemi-arthroplasty (PHA) groups.

Complication Type	ORIF	THA	PHA
Cardiac	0.94%	2.62%	1.74%
Venous thrombosis	1.01%	1.48%	1.23%
Device malfunction	1.15%	1.36%	0.72%
Respiratory	0.60%	1.52%	1.43%
Hemorrhange	0.70%	1.30%	1.37%
GI	0.57%	0.52%	0.88%
Device- infection	0.45%	0.36%	0.61%
Infection	0.34%	0.49%	0.67%
Device- other	0.33%	0.52%	0.64%
Urinary	0.24%	0.43%	0.51%
Transplant	0.24%	0.10%	0.29%
Medical/Surgical complication	0.09%	0.05%	0.10%
Arterial thrombosis	0.11%	0.05%	0.09%
Device- complication	0.03%	0%	0.02%
Other surgical complication	1.85%	4.48%	3.99%
Total Complication Rate	7.59%	13.40%	12.31%

not a modality regularly used for primary treatment of patients under the age of 50 with acute displaced femoral neck fractures [16,17]

While extensive data exist detailing the use of THA in patients over 65, and the use of internal fixation in young patients, this middle-aged group of patients from 45 to 64 does not have similar data supporting an optimal treatment. Our data demonstrates that, in the 12-year period from 2002 to 2014, the rate of arthroplasty for femoral neck fractures in this middle-aged population increased 4.2-fold from 5.4% of operative cases to 20.3% of operative cases. Additionally, it appears that this increase in use is driven by the increase in total number of surgical treated femoral neck fractures that are occurring in this population. It also appears that given the decrease in total percentage of surgical patients being treated with internal fixation of this group, that the increase of total hip arthroplasty use is coming at the expense of internal fixation in this group. This massive change may be partially due to data supporting the increased survivorship of total hip implants, as well as surgeon concern over the rate of avascular necrosis and internal fixation hardware failure in these patients [2,18,20]. Additionally, with the use of THA, many surgeons allow earlier weightbearing than with internal fixation, which may be more appealing to some patients. While this treatment option has become more popular in this population, the in-hospital cost of this surgery was on average $23,343 more than internal fixation of a femoral neck fracture, a 59.3% increase. Additionally, when adjusted for CCI, we found that patients undergoing THA stay in the hospital significantly longer that patients undergoing internal fixation by an average of 1.5 days, and have a higher in-hospital complication rate. With the increasing drive to deliver not only excellent patient care, but also optimal value, more research is needed to determine whether the extra perioperative costs and complications are balanced by improved long-term outcomes. Data is not available in this study for survivorship of either form of treatment.

Recently, a study by Swart et al compared ORIF to THA in patients under the age of 65 in an economic decision analysis model [25]. They found that THA was more cost-effective in patients over the age of 54, and in patients with multiple comorbid conditions between the ages of 44 and 54 [25]. Their study supported the use of ORIF or THA in patients aged 45–64 who sustained femoral neck fractures, while hemiarthroplasty was not recommended [25]. However, they did not examine in-hospital complications, changes in the incidence of these procedures over time, or long-term outcomes of these patients [25].

Potential limitations of this study include the retrospective, non-randomized design, which lacks long-term follow-up. There is no data available for readmission rates or functional outcomes. Our ability to collect data relies on the use of accurate ICD-9 coding for inclusion, which also does not permit differentiation between severity of injury or fracture displacement, which may affect treatment decisions and could possibly bias our results. Because femoral neck fractures in younger patients usually require significant energy transfer, patients may have concurrent injuries that we are unable to adjust for. Similarly, we cannot determine the mechanism of injury for these fractures and how it influenced decision making given the retrospective database nature of this study. However, the sample size is large, and the NIS is widely representative of patients treated in the United States in terms of location, gender, comorbidities, and insurance status. Although billed charges are available for these patients, this data may not represent the true cost of the hospital encounter; however, the NIS does include all-payers, and is meant to be nationally-representative. Additionally, we are unable to calculate the indirect cost associated with these treatments, including time spent out of work and rehabilitation costs. While we were able to demonstrate that, in the short term, patients undergoing THA for femoral neck fractures have increased length of stay, in-hospital complication rates, and hospital costs, we are unable to comment on long-term results associated with these procedures.

Conclusions

The determination of optimal treatment of femoral neck fractures in this age group is becoming increasingly important

as our study shows that an increasing percentage of all femoral neck fractures are occurring in this population. Our study also demonstrates that as patient age increases in this population, the likelihood of receiving a total hip arthroplasty increases as well. We also demonstrated an increased health care burden at the initial hospitalization for patients with femoral neck fractures treated with total hip arthroplasty as compared to internal fixation. While the healthcare burden of treating femoral neck fractures in this age group with total hip arthroplasty does seem to be higher, the rate at which this treatment is being used continues to increase. Additionally, our study demonstrates that the cost of initial hospitalization, in-hospital complication rate, and length of stay are greater in the patients undergoing total hip arthroplasty than internal fixation in this 45–64-year-old patient population.

Conflict of interest

The authors have no pertinent conflicts of interest to report.

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