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Hemiarthroplasty for Displaced Femoral Neck Fractures in the Elderly Has a Low Conversion Rate

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ABSTRACT

Background: Hemiarthroplasty (HA) has been a mainstay treatment for displaced femoral neck fractures for many years. The purpose of this study was to report the conversion rate of HA to total hip arthroplasty (THA) for displaced femoral neck fractures and compare outcomes between implant constructs (bipolar vs unipolar), fixation options (cemented vs cementless stems), and age groups (<75 years vs ≥75 years).
Methods: We retrospectively reviewed the results of a consecutive cohort of 686 patients who underwent HA for the treatment of femoral neck fractures at our institution between 1999 and 2013 with a minimum of 2-year follow-up.
Results: The overall component revision rate, including conversion to THA, revision HA, revision with open reduction internal fixation, and Girdlestone procedure, was 5.6% (39/686). Seventeen patients (2.5%) were converted from HA to THA at an average of 1.9 years after index procedure. A significantly lower conversion rate of 1.4% (7/499 patients) was found in the older patient cohort (≥75 years old) compared to 5.3% (11/187) in the younger cohort. The most common causes for conversion surgery to THA were acetabular wear (5 patients), aseptic loosening (4 patients), and periprosthetic fracture (3 patients). There was a significantly lower rate of periprosthetic fracture (0.4% vs 2.5%, *P* value .025) in the cemented implant group compared to the cementless group. We observed a higher rate of dislocations in the bipolar vs unipolar group (3.8% vs 1%, *P* value .02) and no other significant differences between these groups.
Conclusion: We observed a low reoperation rate for this cohort of patients, relatively higher conversion rates for the younger population, fewer periprosthetic fractures with the use of cemented stems, and no advantage of bipolar over unipolar prostheses.

In the elderly population, femoral neck fractures are a common injury, and their incidence as well as economic burden are increasing [1-3]. Approximately $13 billion per year are utilized for medical care for femoral neck fractures, with majority of cost attributed to patients over the age of 65 [4]. Expedited surgical fixation of femoral neck fractures has been shown to lead to improved outcomes, reduced mortality, and improved function, which is particularly important in the elderly population.

Surgical options for a displaced femoral neck fracture include open reduction internal fixation (ORIF), total hip arthroplasty (THA), and hemiarthroplasty (HA). ORIF is rarely used in the elderly population given the risk of nonunion and worse patient outcomes after a conversion to an arthroplasty after a failed ORIF [5-7]. Recently, some authors have suggested that THA may be more beneficial in the middle-aged, active patient who sustains a femoral neck fracture, due to decreased pain and need for revision secondary to acetabular wear and increased functional scores. In addition, the use of modern large head sizes (36 mm or greater) in THA has reduced the concern for dislocation, which was a primary concern in the elderly patient population [8]. However, HA is still considered a mainstay treatment for displaced femoral neck

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fractures in the less active, elderly patient who does not place high demands on the prosthetic articulation. Surgeons performing a HA worry about the rate of acetabular wear and subsequent need for conversion to a THA in a patient who already is at elevated risk for surgery, although this conversion rate has not been clearly defined in the literature.

In attempts to maximize the longevity of the HA, surgeons can choose to utilize a unipolar or bipolar femoral head and a method of fixation of the femoral stem to the bone using either cement or press-fit options. There is still significant variability among surgeons when choosing among these options. Cemented stems have the potential advantage of a reduced risk of periprosthetic fracture in the elderly population with poor bone integrity [9-13]. However, cemented stems also may carry the risk of increased operative time and perioperative mortality secondary to fat and marrow emboli when compared to cementless stems [11,14]. When comparing femoral head prostheses, bipolar femoral heads have the theoretical advantage of decreasing acetabular cartilage wear and decreasing the rate of dislocation, due to the dual-bearing system [15,16]. It is unclear if this theoretical advantage of improved outcomes has been realized when compared with the less costly unipolar alternative.

A better understanding of the survivorship of HA constructs, the modes of failure, and the optimal HA treatment strategy will allow for improved decision-making in treating displaced femoral neck fractures. The purpose of this study was to report the conversion rate to THA for HA for displaced femoral neck fractures and compare outcomes between implant constructs, fixation options, and age groups.

Methods

Between 1998 and 2013, 817 patients underwent a HA for a displaced femoral neck fracture at 2 different hospitals that are part of the same academic institution. The database was collected through the use of appropriate Current Procedural Terminology (CPT) and International Classification of Disease 9 (ICD-9) codes. Patients who underwent a HA in this period for reasons other than a femoral neck fracture were excluded. Patients with less than 2 years of follow-up and who could not be contacted via telephone were excluded. In addition, patients who were miscoded as a HA, such as those who underwent a resurfacing procedure, were also excluded from this study. These procedures were performed by 19 different orthopedic surgeons.

We retrospectively reviewed the medical records of all 686 patients in this database with a minimum of 2-year follow-up unless the patient was deceased prior to the 2-year end point (mean follow-up 5.4 years, range 2-17 years). The demographics of this patient cohort are outlined in Table 1. The average age of the patient at time of surgery was 81 years. Of the 686 patients, 377 patients underwent a cemented femoral stem and 309 patients underwent a cementless femoral stem. There was a greater proportion of unipolar prostheses (n = 530, 77%) vs bipolar prostheses (n = 156, 23%).

In addition to femoral head implant type and fixation strategy, the medical records were reviewed for estimated intraoperative blood loss, date and reason for conversion to THA or revision surgery, complications, and perioperative mortality (within 10 days of surgery). When examining revision surgery, we only included component revision surgery, which was defined as patients who underwent conversion to THA, revision HA, revision HA with ORIF, or Girdlestone procedure. Conversion surgery is defined as conversion of HA to THA.

The patient database was subdivided into cohorts for further analysis. Patients were divided by age (less than, or greater than, or equal to 75 years), fixation type (cemented vs cementless stems), and femoral head implant type (bipolar vs unipolar). Differences in outcomes between these groups were determined using a chi-square analysis for categorical variables and Student *t* test for continuous variables using JMP statistical software. A *P* value of <.05 was considered statistically significant for the analysis.

Table 1
Study Population.

Demographics and Implant Type	Total Study Population
Number of patients	686
Age	Mean age: 81 y Median age: 83 y Range 15-108 y
Male, female	32% male (217), 68% female (469)
Cemented vs cementless femoral stems	55% (377 cemented), 45% (309 cementless)
Bipolar vs unipolar femoral head	77% (530 unipolar), 23% (156 bipolar)

Results

Revision Surgery

Thirty-nine patients (5.6%) required component revision surgery, which included conversion to THA, revision HA, revision HA with ORIF, or Girdlestone procedure (resection arthroplasty of proximal femur). The most common causes for revision surgery in this patient population were periprosthetic fracture (10 patients, 1.4%), dislocations (10 patients, 1.4%), deep periprosthetic infection (7 patients, 1%), acetabular wear (5 patients, 0.7%), and aseptic loosening (5 patients, 0.7%). One patient (0.1%) underwent revision surgery for an irreducible dislocation of the inner bearing of the bipolar head, and one patient (0.1%) underwent revision surgery for Booker Grade III heterotopic ossification. Younger age at index surgery was also associated with an increased rate of component revision surgery. A 9.6% (18/187) revision rate was found in patients less than 75 years compared to 4.2% (21/499) for patients older than 75 years ($P = .006$).

Conversion to THA

Seventeen patients (2.5%) underwent conversion of the index HA to a THA at an average of 1.9 years (standard deviation 2.1 years, range 1 month-8.5 years). The most common cause for conversion to a THA was periprosthetic acetabular wear (5 patients, 0.7%). The other causes for conversion included aseptic loosening (4 patients, 0.6%), periprosthetic fracture (3 patients, 0.4%), recurrent dislocations (3 patients, 0.4%), and infection (2 patients, 0.3%). Younger age at index surgery was associated with an increased rate of undergoing conversion to THA. Patients less than 75 years showed a 5.3% (10/187) conversion rate to THA as compared to 1.4% (7/499) for patients greater than 75 years ($P = .003$).

Cemented vs Cementless Fixation

There were similar rates of cemented (55%) and cementless (45%) fixation in our cohort. In the cemented fixation group, 3.5% of patients (11/309) underwent conversion to a THA (Table 2) vs 1.6% of patients (6/377) in the cementless fixation group. This difference was not significant ($P = .1$). Similarly, there was no significant difference between component revision surgery for the cementless (16/309, 5.2%) and cemented group (23/377, 6.1%, $P = .60$). There was a significantly higher rate of periprosthetic fractures for the

Table 2
Cemented vs Cementless Femoral Stem Fixation.

Complications	Cemented Stem	Cementless Stem	*P* Value
Component revision surgery	6.1% (23/377)	5.1% (16/309)	.60
Conversion to THA	1.6% (6/377)	3.5% (11/309)	.10
Periprosthetic fracture	0.4% (2/377)	2.5% (8/309)	.03*
Dislocation	1.3% (5/377)	1.6% (5/309)	.75
Aseptic loosening	0.5% (2/377)	1% (3/309)	.50
Acetabular wear	0.5% (2/377)	1% (3/309)	.50
Blood loss (mL)	325	255	.02*
Transfusion rate	29%	30%	.80
Perioperative mortality	1.1% (4/377)	1.0% (3/309)	.91

THA, total hip arthroplasty.
*P-value < .05.

cementless fixation group (8/309, 2.5%) compared to the cemented fixation group (2/377, 0.4%, $P = .025$) (Table 2). There was a significantly higher estimated average blood loss of 325 mL in the cemented fixation group compared to 255 mL in the cementless group ($P = .02$), although this did not prove clinically significant as there was no difference in the rate of blood transfusion ($P = .80$). There were no significant differences between groups for the other complication outcomes including dislocation rate, aseptic loosening, acetabular wear, and perioperative mortality.

Bipolar vs Unipolar Femoral Head

A larger portion of patients underwent HA surgery with the use of a unipolar femoral head (531/686, 77%) vs a bipolar femoral head (156/686, 23%) in this study (Table 3). There were low rates of conversion to THA in the bipolar (1.9%) and unipolar (2.6%) prosthesis groups, ($P = .61$). There were comparable rates of component revision surgery in the bipolar (7.1%) and unipolar (5.3%) prosthesis groups ($P = .40$).

Interestingly, a greater number of dislocations occurred in the bipolar group (5 dislocations, 1 bipolar dissociation, 6/156, 3.8%) compared to the unipolar group (5/530, 0.9%, $P = .02$). There were no significant differences between groups for the other complication outcomes including periprosthetic fracture, aseptic loosening, and acetabular wear.

Discussion

Femoral neck fractures remain one of the most common, debilitating, and cost-consuming fractures in our society, with a high prevalence among the vulnerable elderly population. HA surgery allows the opportunity for rapid recovery and mobilization, reducing the devastating risks associated with a patient being bed bound. While HA hip surgery has been a mainstay treatment for displaced femoral neck fractures in the elderly population for decades, concerns about the longevity of HA, particularly for rates of acetabular wear, and the role for THA surgery in femoral neck fractures remain. The purpose of this retrospective study was to report the conversion rate for HA to THA and compare outcomes between implant fixation techniques, implant design, and age groups. Overall, we observed a low conversion rate (2.5%) for this patient population, with large differences seen in conversion rate seen between the less than 75 years (5.3%) and greater than 75 years (1.4%) cohorts. We observed a 6 times higher rate of periprosthetic fractures with the use of cementless vs cemented stems and no advantage of a more expensive bipolar femoral head over a unipolar design.

Table 3
Bipolar vs Unipolar Femoral Heads.

Complications	Unipolar	Bipolar	*P*-Value
Component revision surgery	5.3% (28/530)	7.1% (11/156)	.40
Conversion to THA	2.6% (14/530)	1.9% (3/156)	.61
Periprosthetic fracture	1.6% (8/501)	1.4% (2/144)	.85
Dislocation	0.9% (5/530)	3.8% (6/156)[a]	.02[a]
Aseptic loosening	0.8% (4/501)	0.7% (1/144)	.90
Acetabular wear	0.8% (4/501)	0.7% (1/144)	.90

THA, total hip arthroplasty.
[a] Includes one bipolar dissociation.

In this study, we observed a low conversion rate from HA to THA of 2.5%. Opponents of HA surgery typically reference a high risk of acetabular wear, which can lead to groin pain, and protrusion of the femoral head in the acetabulum, and will subsequently require conversion to a THA. In the literature, reported acetabular erosion rates are variable, ranging from 0.6% to nearly 100% at long-term follow-up [17,18]. Conversion rates vary as well, with reported rates between 1% and 10%, although the majority of studies suggest a low conversion rate <3% (4% for Van der Bekerom HA 2013, 9.8% Avery JBJS 2011, 2.4% Alazzawi 2012 Clinics in Orthopedics, 1.3% Tanous, and 1.2% Wachtl) [18-22]. Our observed 2.5% conversion rate was similar to these studies, suggesting that the rate of acetabular wear requiring conversion to THA is lower than expected. In addition, while acetabular wear was the most common cause for conversion to THA (5/17), this was not the only cause for conversion, similar to other studies, where acetabular wear is only a portion of primary cause for conversion surgery, for an already small conversion rate [18-22]. Together, this evidence suggests that concern for eventual conversion to THA for acetabular wear in patients undergoing HA for a femoral neck fracture may not be as significant as previously thought.

We chose to analyze differences in conversion rates based on age, dividing the study population into younger (<75 years) and older (>75 years) cohorts. We expected the younger and presumably more active cohort to have higher rates of conversion due to increased rates of wear. Indeed, there was a significant difference in overall revision rate of 9.6% in the younger than 75 years cohort vs 4% in the greater than 75 years cohort and a 4-fold increase in conversion rates to THA for patients less than 75 years (5.3%), compared to greater than 75 years (1.4%). This difference is supported by the literature. Van den Bekerom et al [22], in their longitudinal study following the natural history of 302 patients who underwent HA for displaced femoral neck fractures, they reported a hazard ratio (HR) of 3.6 for risk for revision surgery for patients less than 75 years of age. Leonardsson et al [23], in a large Swedish registry study, found similarly increased rates of revision surgery in patients less than 75 years of age (HR 1.8), with an extremely large difference in revision rate due to acetabular erosion between these age groups (HR 46.2). This evidence suggests that in conjunction with the overall low reported rates of conversion surgery, concern for acetabular erosion should be limited to patients less than 75 years of age.

Another major controversy exists over the optimal method of fixing the femoral stem to the bone. Due to differences in bone quality in this population, careful consideration is needed when choosing between press-fit and cemented stem designs. Proponents of cemented stems in the elderly cite a reduced risk of periprosthetic fracture when compared to press-fit femoral stems. In our study, we report a 6-fold increased rate of periprosthetic fracture in patients with a cementless femoral stem when compared to a cemented femoral stem. Multiple randomized control trials, as well as large prospective registry studies, have similarly demonstrated this increased risk [9-12]. Langslet et al [9] reported a periprosthetic fracture rate of 7.4% for cementless stems vs 0.9% for cemented stems. Gjertsen et al [11] report a hazard rate ratio of 16.6 for periprosthetic fractures favoring cemented stems. Of note, in our study, this increased rate did not translate to an

increased rate of conversion or revision surgery. Potential advantages of cementless femoral stems include decreased operative time, reduced risk of perioperative mortality due to lower incidence of fat and marrow embolism. While our study was not appropriately structured to analyze perioperative mortality, we did not see a difference in early mortality rates or transfusion rates between these groups. The literature suggests that the difference in perioperative mortality may be real, although it is extremely low, and is not maintained past the initial perioperative period [11,14]. Based on our evidence, and evidence in the literature, cemented fixation may be more beneficial for patients with poor bone quality to reduce the risk of periprosthetic fracture. While age is one factor which may affect bone quality and, therefore, periprosthetic fracture risk, determining more specific guidelines for cemented vs cementless stems will help define indications for cemented vs cementless stems.

Another point of contention centers on the ideal articulation to employ in the setting of a femoral neck fracture. Bipolar femoral heads were introduced as a potential solution to combat acetabular erosion, with the theoretical advantage of decreasing acetabular cartilage wear due to the dual-bearing system. However, few studies have shown a significant difference in the development of acetabular arthritis secondary to the metal-on-cartilage articulation between bipolar and unipolar prostheses, or they have shown that differences in wear rates were present for one year, but these differences disappeared at later time points [15,16,24-27]. In this study, we report similarly low rates of conversion surgery secondary to acetabular wear (0.7% vs 0.8%) and no differences in overall conversion surgery or revision surgery rate between the 2 groups. When including bipolar dissociation, we did see a significant increased risk of dislocation in the bipolar group compared to the unipolar (3.8% vs 0.9%). Given the increased costs of a bipolar prosthesis [15,16,28,29] and no strong evidence for increased benefit in this study, a unipolar prosthesis should be considered for HA.

The primary weakness of this study was its retrospective nature, which may have hampered the ability to obtain long-term follow-up, which may demonstrate increased conversion rate at 5 or 10 years. In order to address this weakness, we attempted to contact all patients who had less than 2 years of follow-up. However, we acknowledge that 2 years of follow-up will not address all revision surgery. The average time to conversion surgery in our study population was 1.9 years, but it is possible that a portion of patients lacking long-term follow-up may have required conversion surgery without our knowledge. Our rates of conversion surgery were similar to previously reported rates, although are on the lower end, and may have been higher if 100% long-term follow-up (past 5 years) could be obtained.

Conclusions

For the younger, more active population, the literature supports THA over HA, with advantages including improved function, decreased pain, and possibly lower revision rates [30-34]. However, HA remains an important treatment strategy for displaced femoral neck fractures in the elderly. In this study, we observed very low rates of conversion to THA, suggesting that concern for acetabular wear following HA surgery should be limited to the younger (<75 years) population. We observed fewer periprosthetic fractures with the use of cemented stems and no advantage of bipolar femoral heads compared to unipolar femoral heads. These data, along with supporting literature, suggest that cemented unipolar HA for a displaced femoral neck fracture in the elderly patient with poor bone quality is an appropriate option to reduce periprosthetic fracture risk, maintain low revision rates, and reduce costs without compromising outcomes.

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