Trends in Surgical Management of Femoral Neck Fractures in the United States

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Abstract We examined trends in utilization of open reduction and internal fixation (ORIF), THA, and hemiarthroplasty (HA) for femoral neck fractures. Closed femoral neck fractures managed with ORIF or hip arthroplasty ($n = 162,257$) were extracted from 1990 to 2001 Nationwide Inpatient Samples. Trends were examined during three periods (1990–1993 [Period I], 1994–1997 [Period II], and 1998–2001 [Period III]). Utilization of HA

increased from 67.8% in Period I to 75.3% in Period III. In the same period, utilization of THA decreased from 11.6% to 6.6%. The trend of decreased use of THA was consistent regardless of age, hospital, or surgeon volume. In Period III, 28.7% of patients were managed at urban teaching hospitals as compared with 19.6% in Period I. Increased utilization of HA conforms with recent evidence that arthroplasty has better outcomes than ORIF. However, the decrease in THA is contrary to what was expected, and its impact on patient outcomes needs to be evaluated. The increase in the proportion of femoral fractures managed at urban teaching hospitals may reflect a change in the organization of trauma systems during the last decade.

Level of Evidence: Level II, diagnostic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Introduction

Fractures of the femoral neck are common, disabling, and expensive [19]. They rarely are managed nonoperatively, and this generally occurs only when the patient or family choose to initiate comfort measures only. Surgical management options for femoral neck fractures include ORIF, HA, and THA [5, 15].

Although there is debate regarding the preferred procedure for management of displaced femoral neck fractures, recent studies suggest arthroplasty has better outcomes as compared with ORIF [7, 8, 14, 22], and one report suggests THA may have better outcomes as compared with HA in elderly patients [14]. However, in many patients, THA can be more technically challenging owing to the nature of the fracture. In patients without fractures,

THA has optimal outcomes when performed by surgeons who perform a high-volume of arthroplasties [3, 12, 13, 16]. In situations when arthroplasty is the optimal management, other factors such as surgeons' technical expertise, surgeons' annual THA or HA volume, and variation in practice patterns across hospitals also may play a role in surgical decision-making.

Thus, the best choice of surgical procedure for hip fracture is complex and evolving. Numerous studies have provided evidence for better outcomes after arthroplasty (HA or THA) as compared with ORIF [4, 7, 10, 11, 17, 20–22]. However, there are no established clinical guidelines for indications and choice of surgical procedures for patients with femoral neck fractures. To gain insight into this clinical choice, it would be useful to determine trends in utilization of procedures performed for patients with femoral neck fractures in actual clinical practice across the United States and assess whether these trends conform to recent evidence in the literature. It would be helpful for clinicians and policymakers to determine whether these trends are influenced by patient, hospital, and surgeon characteristics.

Therefore, we examined trends in relative utilization of ORIF, HA, and THA for closed femoral neck fractures during the last decade in the United States. We also assessed whether utilization trends varied by three provider characteristics: hospital volume, hospital location, and surgeon volume.

Materials and Methods

We used the Nationwide Inpatient Sample databases for 1990 through 2001. The Nationwide Inpatient Sample is a part of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality [1]. The Nationwide Inpatient Sample is the largest all-payer inpatient care database publicly available in the United States and contains between five and eight million records of inpatient stays per year from approximately 1000 hospitals. This represents a 20% stratified sample of community hospitals in the United States [1]. To ensure maximal representation of US hospitals, the Nationwide Inpatient Sample included hospitals according to five important hospital characteristics: geographic region (Northeast, North Central, West, South); ownership (public, private not-for-profit, private investor-owned); location (urban, rural); teaching status (teaching hospital, non-teaching hospital); and bed size (small, medium, large). Additional details on these variables can be found at the HCUP web site [1].

The HCUP assigned validation and quality assessment of these data sets to an independent contractor [2]. The

Nationwide Inpatient Sample also was validated extensively against the National Hospital Discharge Survey and confirmed to perform well for many estimates [23].

The Nationwide Inpatient Sample database contains information on primary International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) diagnosis and procedure codes and 14 secondary diagnoses and procedure codes for each patient record. Each record in the data set represents one patient admission and has a unique identification number. We selected admissions with an ICD-9-CM primary diagnosis code for closed transcervical fracture of femoral neck (820.00, 820.01, 820.02, 820.09). We included patients in whom ORIF (79.35), HA (81.52), or THA (81.51) was designated as the primary procedure code, which represented a majority of patients ($n = 163,209$ of 164,093 patients with femoral neck fractures; 99.5% of patients). Other procedures such as internal fixation without reduction (including prophylactic internal fixation of bone, reinsertion of fixation device, revision of broken or displaced fixation device; $n = 13,307$) and closed reduction with internal fixation ($n = 12,654$) were used in fewer patients. We also did not include patients with closed base of femoral neck fractures because their management is different from that of patients with other femoral neck fractures ($n = 13,058$). Records in which the same patient had a primary procedure code for one of the three procedures (ORIF, HA, or THA) and also a secondary procedure code for one of the three procedures also were not included ($n = 952$). Our final analysis included 162,257 patients who had surgical repair of a closed transcervical femoral neck fracture between 1990 and 2001 (Fig. 1).

We grouped the admissions into the three periods: Period I (1990–1993), Period II (1994–1997), and Period III (1998–2001), creating approximately equal intervals. Patient race-ethnicity was categorized in the Nationwide Inpatient Sample databases as white, black, Hispanic, and other (including Asian or Pacific Islander and Native American). The category “black” may include African-American and Caribbean-American patients. We categorized age into younger than 50, 50 to 64, 65 to 79, and 80 years or older based on distribution of procedure utilization within age groups. A majority of patients managed surgically for femoral neck fractures were female (75% to 78% in Periods I through III), white (91% to 94% in Periods I through III), and in age groups of 65 to 79 and 80 years or older (Table 1).

Hospital teaching status for a given year was obtained from the American Hospital Association Annual Survey by the HCUP. A hospital was considered a teaching hospital if it had an American Medical Association-approved residency program, was a member of the Council of Teaching Hospitals, or had a ratio of full-time-equivalent interns and

Fig. 1 The case inclusion schema is shown for patients with femoral neck fractures undergoing HA, THA, or ORIF. ICD-9-CM = International Classification of Diseases, 9th Revision, Clinical Modification.

residents to beds of 0.25 or greater. We characterized hospitals as urban if they were in a metropolitan statistical area and rural if they were in a nonmetropolitan statistical area. We calculated hospital volume per year for THA and HA separately using unique hospital identifiers provided in the databases. This was performed by looking at all THA and HA procedures performed by a given hospital in the entire Nationwide Inpatient Sample data sets. Thus, THA and HA annual volumes were calculated for each of these respective procedures performed in a hospital for any indication (and not only for femoral neck fractures). Annual hospital volume of THA was divided into zero procedures, one to 24 procedures, 25 to 99 procedures, 100 to 199 procedures, and 200 or more procedures; and that of HA was divided into zero procedures, one to 14 procedures, 15 to 25 procedures, 25 to 100 procedures, and 100 or more procedures. This was based on the distribution of procedure utilization in our patient population. Annual THA and HA surgeon volume was calculated in a similar way. Because surgeon identifiers were missing in 46% of patient records, we could not determine whether a surgeon did not perform any THAs or HAs in a year or the

information was missing. Therefore, for records with available surgeon identifiers, we divided annual surgeon volume of THA into one to nine procedures, 10 to 19 procedures, 20 to 49 procedures, and 50 or more procedures; and that of HA was divided into one to four procedures, five to nine procedures, 10 to 20 procedures, and 20 or more procedures. We performed analyses to determine if surgeon identifier was especially likely to be missing in particular patient or provider groups. These analyses indicated the missing data were distributed evenly across patient and hospital characteristics.

We described patient demographics, surgeon characteristics, and hospital characteristics across periods using proportions. The overall association between times and the distribution of ORIF, HA, and THA utilization was examined using the chi square test of independence. Additional analyses focused on identification of factors influencing the association between times and the distribution of ORIF, HA, and THA. Factors considered were age, hospital volume, and surgeon volume. We performed statistical analyses using Intercooled STATA for Windows (version 8.2; Stata Corp, College Station, TX) and SAS for Windows (version 9.1; SAS Institute Inc, Cary, NC).

Results

Overall, the proportion of patients undergoing HA increased from 67.8% in Period I to 75.3% in Period III (Fig. 2). However, the proportion of patients undergoing THA diminished ($p < 0.001$) from 11.6% in Period I to 6.6% in Period III. When stratified by age, a majority of patients younger than 50 years underwent ORIF in all three periods (Table 2). Hemiarthroplasty was performed in a majority of patients in the 65 to 79 years (67.1% to 75.2% between Periods I and III) and 80 years or older (71.6% to 78.5% between Periods I and III) age groups. The proportion of patients undergoing HA in these age groups increased ($p < 0.001$) steadily between Periods I and III (from 67.1% to 75.2% in patients 65 to 79 years and from 71.6% to 78.5% in patients of 80 years or older). However, we observed an overall trend of a declining proportion ($p < 0.001$) of patients undergoing THA with time across all age groups.

We found a decline ($p < 0.001$) in utilization of THA across all hospital volume categories (Table 3). In hospitals with an annual THA volume of 200 or more procedures, THA was performed in 18.8% of patients in Period I and 8.9% of patients in Period III. In hospitals with annual THA volumes of one to 24 procedures, 8.6% of patients received THA in Period I and 5.7% in Period III. Similar trends were observed in distribution of procedures across surgeon THA volume categories (data not shown because

Table 1. Baseline characteristics of patients managed surgically, 1990–2001

Characteristics	Time		
	1990–1993 (Period I) (n = 47,435) Number (percentage of patients)	1994–1997 (Period II) (n = 59,269) Number (percentage of patients)	1998–2001 (Period III) (n = 55,553) Number (percentage of patients)
Age (years)			
Younger than 50	849 (1.8)	1011 (1.7)	993 (1.8)
50–64	2644 (5.6)	2981 (5.0)	2939 (5.3)
65–79	17,366 (36.6)	20,348 (34.3)	18,131 (32.6)
80 or older	26,473 (55.8)	34,919 (58.9)	33,489 (60.3)
Gender			
Female	36,828 (77.6)	45,550 (76.9)	42,132 (75.8)
Male	10,607 (22.4)	13,716 (23.1)	13,419 (24.2)
Race*			
White	25,166 (94.2)	45,591 (92.9)	40,538 (91.1)
Black	638 (2.4)	1585 (3.2)	1595 (3.6)
Hispanic	586 (2.2)	1284 (2.6)	1400 (3.1)
Other†	335 (1.3)	638 (1.3)	986 (2.2)
Hospital bed size			
Small	4,594 (9.7)	9,018 (15.2)	7,848 (14.1)
Medium	13,695 (29.0)	19,199 (32.5)	15,966 (28.8)
Large	29,025 (61.4)	30,956 (52.3)	31,687 (57.1)
Location and teaching status of hospital			
Rural	7587 (16.0)	10,492 (17.7)	11,180 (20.1)
Urban nonteaching	30,442 (64.2)	35,945 (60.7)	28,395 (51.1)
Urban teaching	9285 (19.6)	12,736 (21.5)	15,926 (28.7)
Hospital annual THA volume			
0	1326 (2.8)	1249 (2.1)	921 (1.7)
1–24	13,727 (28.9)	15,390 (26.0)	13,494 (31.7)
25–99	22,787 (48.0)	29,642 (50.1)	26,328 (47.4)
100–199	7366 (15.5)	10,431 (17.6)	11,597 (20.9)
200 or more	2229 (4.7)	2557 (4.3)	3213 (5.8)
Hospital annual HA volume			
0	198 (0.4)	75 (0.1)	74 (0.1)
1–14	7638 (16.1)	6667 (11.3)	5807 (10.5)
15–25	7636 (16.1)	8022 (13.5)	8393 (15.1)
25–100	30,110 (63.5)	40,170 (67.8)	36,667 (66.0)
100 or more	1853 (3.9)	4335 (7.3)	4612 (8.3)
Surgeon annual THA volume			
1–9	12,529 (26.4)	18,543 (31.3)	12,305 (22.2)
10–19	4781 (10.1)	7622 (12.9)	5385 (9.7)
20–497	2665 (5.6)	4231 (7.1)	2567 (4.6)
50 or more	485 (1.0)	803 (1.4)	764 (1.4)
Not reported	26,975 (56.9)	28,070 (47.4)	34,532 (62.2)
Surgeon annual HA volume			
1–4	7198 (15.2)	10,534 (17.8)	7314 (13.2)
5–9	8590 (18.1)	11,729 (19.8)	8685 (15.6)

Table 1. continued

Characteristics	Time		
	1990–1993 (Period I) (n = 47,435) Number (percentage of patients)	1994–1997 (Period II) (n = 59,269) Number (percentage of patients)	1998–2001 (Period III) (n = 55,553) Number (percentage of patients)
10–20	5868 (12.4)	10,820 (18.3)	6825 (12.3)
20 or more	1402 (3.0)	3343 (5.6)	2154 (31.2)
Not reported	24,377 (51.4)	22,843 (38.5)	30,575 (55.0)

Overall missing for age n = 114 (0.1%); for gender n = 5 (0.0%); for hospital bed size n = 269 (0.2%); for location and teaching status of hospital n = 269 (0.2%); *as a result of a high percentage missing for race (43.7% for 1990–1993; 17.2% for 1994–1997; and 19.9% for 1998–2001), percentages are expressed as those of data excluding missing values; †other includes Asian or Pacific Islander, Native American, and other.

Fig. 2 Temporal trends in increased utilization of HA and decreased utilization of THA for surgical management of femoral neck fractures are shown. ORIF = open reduction and internal fixation.

this analysis was exploratory as a result of missing data on surgeon identifiers). An increasing proportion ($p < 0.001$) of patients were managed at urban teaching hospitals in the later periods (28.7 in Period III as compared with 19.6 in Period I). The distribution of missing surgeon identifiers was similar across hospital and patient characteristics. Surgeons performing 50 or more THAs per year used THA in 27.0% of their patients in Period I as compared with 16.9% in Period III. During the same period, surgeons with annual THA volumes of one to nine procedures used THA in 10.0% of their patients in Period I as compared with 7.7% in Period III. The proportion of patients managed across hospital and surgeon volume categories remained consistent throughout the three periods with most procedures being performed by low- to medium-volume providers.

Table 2. Temporal trends in surgical management by age, 1990–2001

Surgical procedure by age*	Time		
	1990–1993 (Period I) (n = 47,435) Number (percentage of patients)	1994–1997 (Period II) (n = 59,269) Number (percentage of patients)	1998–2001 (Period III) (n = 55,553) Number (percentage of patients)
Younger than 50 years			
ORIF	657 (77.4)	759 (75.1)	776 (78.2)
HA	153 (18.0)	212 (21.0)	188 (18.9)
THA	39 (4.6)	40 (4.0)	29 (2.9)
50–64 years			
ORIF	1041 (39.4)	1059 (35.5)	933 (31.8)
HA	1293 (48.9)	1624 (54.5)	1745 (59.4)
THA	310 (11.7)	298 (10.0)	261 (8.9)
65–79 years			
ORIF	3571 (20.6)	3955 (19.4)	3214 (17.7)
HA	11,651 (67.1)	14,490 (71.2)	13,642 (75.2)
THA	2144 (12.4)	1903 (9.4)	1275 (7.0)
80 years or older			
ORIF	4524 (17.1)	5678 (16.3)	5116 (15.3)
HA	18,963 (71.6)	26,773 (76.7)	26,280 (78.5)
THA	2986 (11.3)	2468 (7.1)	2093 (6.3)

*Overall missing for age n = 114 (0.1%).

Discussion

The best choice of surgical procedure for hip fracture is complex and evolving. We examined trends in relative utilization of ORIF, HA, and THA for closed femoral neck fractures during the last decade in the United States.

The limitations of our study include lack of information for clinical variables such as the degree of displacement of fractures, presence of osteoporosis, extent of osteoarthritis in the hip, prior functional status, and acetabular integrity, as these variables are not available from the databases. Because controversy regarding choice of procedure exists mainly in the management of displaced femoral neck fractures, whether the fracture was displaced plays an important role in surgical decision-making. It is unlikely there would be systematic differences in distribution of displaced versus nondisplaced femoral neck fractures with time. Also, most reports comparing THA versus HA were published after the duration of our study. However, the objective of our study was to determine trends in utilization of surgical procedures for management of femoral neck fractures and not to study which procedure had better patient outcomes. Our data source had 46% missing surgeon identifiers, making our analysis of surgeon volume exploratory. The distribution of missing surgeon identifiers,

Table 3. Temporal trends in surgical management by hospital and surgeon volume, 1990–2001

Annual volume	Time		
	1990–1993 (Period I) (n = 47,435) Number (percentage of patients)	1994–1997 (Period II) (n = 59,269) Number (percentage of patients)	1998–2001 (Period III) (n = 55,553) Number (percentage of patients)
Hospital THA			
0			
ORIF	194 (14.6)	224 (17.9)	179 (19.4)
HA	1132 (85.4)	1025 (82.1)	742 (80.6)
THA	0 (0.0)	0 (0.0)	0 (0.0)
1–24			
ORIF	3045 (22.2)	3057 (19.9)	2414 (17.9)
HA	9497 (69.2)	11,351 (73.8)	10,309 (76.4)
THA	1185 (8.6)	982 (6.4)	771 (5.7)
25–99			
ORIF	4670 (20.5)	5637 (19.0)	4670 (17.7)
HA	15,445 (67.8)	21,562 (72.7)	19,945 (75.8)
THA	2672 (11.7)	2443 (8.2)	1713 (6.5)
100–199			
ORIF	1362 (18.5)	2029 (19.5)	2146 (18.5)
HA	4792 (65.1)	7477 (71.7)	8563 (73.8)
THA	1212 (16.5)	925 (8.9)	888 (7.7)
200 or more			
ORIF	533 (23.9)	505 (19.8)	630 (19.6)
HA	1278 (57.3)	1693 (66.2)	2297 (71.5)
THA	418 (18.8)	359 (14.0)	286 (8.9)
Hospital HA			
0			
ORIF	89 (45.0)	41 (54.7)	40 (54.1)
HA	0 (0.0)	0 (0.0)	0 (0.0)
THA	109 (55.1)	34 (45.3)	34 (46.0)
1–14			
ORIF	1772 (23.2)	1558 (23.4)	1244 (21.4)
HA	4357 (57.0)	4162 (62.4)	3945 (67.9)
THA	1509 (19.8)	947 (14.2)	618 (10.6)
15–25			
ORIF	1649 (21.6)	1606 (20.0)	1569 (18.7)
HA	4895 (64.1)	5682 (70.8)	6188 (73.7)
THA	1092 (14.3)	734 (9.2)	636 (7.6)
25–99			
ORIF	6006 (20.0)	7494 (18.7)	6483 (17.7)
HA	21,420 (71.1)	29,891 (74.4)	28,042 (76.5)
THA	2684 (8.9)	2785 (6.9)	2142 (5.8)
100 or more			
ORIF	288 (15.5)	753 (17.4)	703 (15.2)
HA	1472 (79.4)	3373 (77.8)	3681 (79.8)
THA	93 (5.0)	209 (4.8)	228 (4.9)

however, was similar across hospital and patient characteristics suggesting this would not substantially alter the findings.

There is debate regarding the best surgical management of displaced femoral neck fractures [5]. Numerous studies have provided evidence for better outcomes after arthroplasty (HA or THA) as compared with internal fixation [4, 7, 10, 11, 17, 20–22]. Blomfeldt et al. performed a randomized, controlled trial of 102 elderly patients with displaced femoral neck fractures [7]. The rate of hip complications was 4% in patients undergoing THA as compared with 42% in the internal fixation group. Revision rates were 4% in the THA group and 47% in the internal fixation group. Rogmark et al. performed a similar study comparing arthroplasty with internal fixation [20] and reported higher rates of failure and poor functional outcomes, as measured by pain and impaired walking ability, in patients undergoing internal fixation as compared with arthroplasty. Bhandari et al. reported a meta-analysis of randomized trials comparing arthroplasty and internal fixation between 1969 and 2002 [4]. Among 1933 patients, the authors reported patients undergoing arthroplasty had a relative risk of 0.23 for revision surgery as compared with those who had internal fixation. There was no difference between the two groups in pain relief after surgery, but the risk of infection was greater with arthroplasty as compared with internal fixation (relative risk = 1.81 for arthroplasty versus internal fixation).

The literature comparing THA and HA for displaced femoral neck fractures is less conclusive. In a recently reported study [14], Keating et al. reported that rates of fixation failure, hip dislocation, revision surgery, and postoperative morbidity were similar between HA and THA. However, functional outcomes and quality of life were considerably better in the THA group as compared with the HA group. Two other studies also suggest better outcomes with THA as compared with HA [8, 18]. In a recent randomized trial, Blomfeldt et al. studied elderly patients with acute displaced intracapsular fracture of the femoral neck and concluded total hip replacement provided better function than a bipolar HA, without increasing the complication rate [6]. However, these studies have methodologic limitations such as small sample size, short duration of followup, inadequate information on randomization technique, and limited number of outcomes that were compared.

Our study shows an increase in the use of HA and a small decrease in the utilization of ORIF during the last decade. Contrary to what was expected, there also was a decrease in the utilization of THA. We observed the decrease in THA utilization across all age groups, hospital volume categories, and surgeon volume categories. The trend of minor reduction in ORIF and increase in HA with

time conforms to recent studies showing better outcomes with arthroplasty as compared with internal fixation for displaced femoral neck fractures. However, a trend of decreasing THA utilization also was observed. It is likely that because there is no definitive evidence or clear clinical guidelines for use of HA versus THA in patients with femoral neck fractures, surgeons choose a technically less demanding procedure, ie, HA (particularly in less active patients). Additionally, there is evidence that better outcomes are achieved if a procedure is performed by a surgeon with high volume for the respective procedure. This has been reported for hip arthroplasties in patients without fractures [3, 13] and for shoulder arthroplasties in patients with and without fractures [9]. Therefore, outcomes may be better for a patient with a femoral neck fracture if a surgeon with low THA volume and high HA volume performs a HA. This also could be a factor in surgical decision-making.

Although evidence for better outcomes with arthroplasty as compared with internal fixation existed during the time frame of our study, most evidence comparing THA and HA was published after 2000. Given the decreasing utilization of THA in our study, it becomes essential to compare outcomes of THA versus HA for displaced femoral neck fractures. Clinical trials comparing the two procedures should be performed. Practice may lag behind the evidence. This may explain in part the decline in THAs despite preliminary evidence supporting the procedure.

In the absence of definitive trials, it is not possible to comment on whether the trend of decreasing THA utilization observed in our study is beneficial from the standpoint of patient outcomes. The role of hospital cost in the decision to perform HA versus THA is also an important variable that cannot be evaluated further from our data. It is possible, and in many cases appropriately so, that in the absence of definitive clinical guidelines hospitals/surgeons prefer HA as compared with THA owing to the cost differential. Therefore, it is essential that professional organizations develop evidence-based guidelines for the choice of procedure(s) for femoral neck fractures in different clinical situations.

Urban teaching hospitals had an increasing proportionate share of patients in the later periods of our study. Because femoral neck fracture is generally an urgent medical condition, this trend likely represents a change in the organization of trauma systems (the treatment and referral patterns of injured senior citizens) in the recent decade encouraging more patients to be transferred to academic urban hospitals by emergency services. Other possible reasons for this trend include patient preferences and referral patterns of other physicians or reductions in reimbursements with a shifting of patients to teaching hospitals. Older patients also are more likely to have

multiple medical comorbidities, making their perioperative course more complex and more suitable for urban teaching hospitals.

Our study provides evidence for changing trends in the management of femoral neck fractures during the last decade. Some of these trends such as the decreasing utilization of THA raise important clinical and policy questions as described. The implications of possible variation in surgical practice by nonclinical factors such as the surgeons' annual THA volume on patient outcomes should be investigated. Results of our study also emphasize the need for better clinical guidelines and studies on the comparison of THA and HA for displaced femoral neck fractures.

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