

RESEARCH ARTICLE

In-Hospital Outcomes after Hemiarthroplasty versus Total Hip Arthroplasty for Isolated Femoral Neck Fractures

Timothy Voskuijl, MD; Valentin Neuhaus, MD; Ahmet Kinaci, BSc; Mark Vrahas, MD; David Ring, MD PhD

Research performed at Massachusetts General Hospital, Boston, MA, USA

Received: 5 June 2014

Accepted: 24 August 2014

Abstract

Background: Previous studies suggest total hip arthroplasty may have some benefits compared to hemi-arthroplasty for displaced intracapsular femoral neck fractures in patients more than 60 years of age. The primary research question of our study was whether in-hospital adverse events, post-operative length of stay (LOS) and mortality in patients 60 year of age or older differed between total hip and hemi-arthroplasty for femoral neck fracture.

Methods: We obtained data on 82951 patients more than 60 years of age with an isolated femoral neck fracture treated with either hemi-arthroplasty or total hip arthroplasty in 2009 or 2010 from the National Hospital Discharge Survey (NHDS) database. The International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9, CM) was used to code diagnoses, comorbidities, complications, and procedures.

Results: Controlling for demographics and comorbidities, patients treated with hemi-arthroplasty had a 40% (95% CI 1.4-1.5) higher risk of adverse events compared to patients treated with a total hip arthroplasty. Length of stay and in-hospital mortality did not differ between these groups.

Conclusions: The observed advantage for total hip arthroplasty might reflect greater infirmity in hemi-arthroplasty patients that was not accounted for by ICD-9 codes alone.

Key words: Complication, Femoral neck fracture, Hemiarthroplasty, Inpatient, Length of stay, Mortality, Total hip arthroplasty

Introduction

Displaced intracapsular femoral neck fractures in the elderly are traditionally treated with hemi-arthroplasty. However, in the healthier, higher demand patient a total hip arthroplasty may have its benefits. The best treatment is an area of debate. On the one hand, total hip arthroplasty may be preferred because of lower re-operation rates, better pain relief and functional outcomes (1-7). On the other hand, hemi-arthroplasty may have fewer dislocations than total hip arthroplasty (1-3, 6-7). No differences are found in mortality rates after 30 days up until nine years after discharge (1,2, 6-11). The reported complication rates diverge between studies without a clear trend for or against one treatment option (1, 3, 7, 9).

Corresponding Author: David Ring, Orthopaedic Hand and Upper Extremity Service, Harvard Medical School, Massachusetts General Hospital, Yawkey Center, Suite 2100, 55 Fruit Street, Boston, MA 02114, USA.

Email: dring@partners.org

Our primary study question was whether differences were found in inpatient adverse events, length of stay, and inpatient mortality between hemi-arthroplasty or a total hip arthroplasty after an isolated femoral neck fracture in the elderly, controlling for demographics and comorbidities. Secondary purposes were to determine general predictors for inpatient adverse events, length of stay, and inpatient death after arthroplasty for femoral neck fracture.

Materials and Methods

Institutional Review Board (IRB) approval was obtained to distract data from the National Hospital Discharge Survey (NHDS) database - a national survey conducted annually from 1965 - 2010 about inpatients



THE ONLINE VERSION OF THIS ARTICLE
ABJS.MUMS.AC.IR

Table 1. Patient characteristics

	Mean (\pm SD)	Total		Hemi-arthroplasty		Total hip arthroplasty	
		N = 82591 (100%)	N = 74088 (90%)	N = 78 (\pm 8.2)	N = 60-90	N = 78 (\pm 8.2)	N = 60-90
Age (years)	Mean (\pm SD)	82 (\pm 7.8)	60-90	82 (\pm 7.7)	60-90	78 (\pm 8.2)	60-90
Sex	Male	25153	31	23263	31	1890	22
	Female	57438	69	50825	69	6613	78
Race	White	69369	84	60978	82	9391	99
	Black / African American	2685	3.3	2685	3.6	0	0
	Asian	709	0.86	709	1.0	0	0
	Other	1857	2.2	1857	2.5	0	0
	Not stated	7971	9.7	7859	11	112	1.3
Marital Status	Married	15137	18	14077	19	1060	12
	Single	3705	4.5	2955	4.0	750	8.8
	Widowed	23016	28	19578	26	3438	40
	Divorced / Separated	2200	2.7	2200	3.0	0	0
	Not stated	38533	47	35278	48	3255	38
Source of payment	Medicare	73130	89	66348	90	6782	80
	Other	9461	12	7740	10	1721	20
Days of care	Mean (\pm SD)	5.7 (\pm 2.8)	1-35	5.6 (\pm 2.8)	1-35	6.0 (\pm 2.9)	3-19
Discharge status	Routine / Home	6513	7.9	5125	6.9	1388	16
	Short-time facility	9052	11	7973	11	1079	13
	Long-term institution	50670	61	45244	61	5426	64
	Alive, position not stated	11047	13	10682	14	365	4.3
	Dead	1009	1.2	898	1.2	111	1.3
	Not reported	4300	5.2	4166	5.6	134	1.6
Any comorbidity	No	17915	22	14917	20	2998	35
	Present	64676	78	59171	80	5505	65
Any complication	No	25515	31	21866	30	3649	43
	Present	57076	69	52222	70	4854	57

discharged from non-Federal short-stay hospitals in the United States. It provides information about patients' characteristics as well as medical information.

The inclusion criteria for this study were 1) age older than 60 years, 2) an isolated femoral neck fracture (no other fractures or dislocations), and 3) treatment with either hemi-arthroplasty or total hip arthroplasty in 2009 or 2010. An estimated 82951 patients met the inclusion criteria (Table 1). The majority of patients were white (84%) and female (69%). The mean age was 82 (\pm 7.8) years. Ninety percent (74088 patients) were treated with a hemi-arthroplasty. The mean length of stay was 5.7 (\pm 2.8) days.

Age, sex, race, marital status, source of payment, length of stay, discharge status, a maximum of 15 diagnoses (including femoral neck fracture) and a maximum of 8 procedures were recorded. The International Classification of Diseases, 9th Revision, Clinical

Modification (ICD-9, CM) was used to code diagnoses, comorbidities, complications, and procedures (see Appendix A for all diagnoses / procedures and their corresponding ICD-9 codes used in this study).

Statistical analysis

The outcome variables were inpatient adverse events, length of stay, and inpatient death. A significantly longer hospital stay was a priori defined as mean +2SD days or longer - which was 11.3 days or longer. Patient characteristics, comorbidities and adverse events (where applicable) were explanatory variables. The chi-square test for categorical variables and the Student's t-test for continuous variables were used. For multivariable analysis, all variables which differed significantly ($P < 0.001$) and with an overall prevalence of more than 2% (for any complication the overall prevalence had to be at least 1% to be included) were next entered into

Table 2. Predictors of any complication after hemi- or total hip arthroplasty for isolated femoral neck fracture* (n = 82591)

Parameter	Significance	Odds ratio	95% confidence interval	
			Lower	Upper
Congestive heart failure	<0.001	8,2	7,5	9,0
Malignancy	<0.001	8,1	6,8	9,7
Nutritional deficiency	<0.001	3,2	2,9	3,6
Essential hypertension	<0.001	2,0	1,9	2,1
Female sex	<0.001	1,9	1,8	2,0
Chronic Kidney Disease	<0.001	1,5	1,3	1,6
Hemi-arthroplasty	<0.001	1,4	1,4	1,5
Diabetes	<0.001	1,4	1,3	1,5
Days of Care	<0.001	1,2	1,2	1,2
Age	<0.001	1,1	1,1	1,1
Marital status: married	<0.001	0,75	0,72	0,78
Atrial fibrillation	<0.001	0,61	0,58	0,64
Osteoporosis	<0.001	0,60	0,57	0,63
n, number of patients in the cohort				
* variables included in the regression: age, sex, marital status, type of surgery, days of care, essential hypertension, hypertensive disease, atrial fibrillation, congestive heart failure, COPD, chronic kidney disease, diabetes, osteoporosis, malignancy, nutritional deficiency				

a backward stepwise logistic regression model (12, 13).

Results

Inpatient Adverse Events

Inpatient adverse events occurred in 57076 (69%) patients. The implantation of hemi-arthroplasty was associated with more inpatient adverse events (OR 1.4) compared to total hip arthroplasty while controlling for comorbidities. Congestive heart failure and malignancy were the greatest predictors for inpatient adverse events (Table 2).

Length of stay

Two and a half percent (n=2035) of all patients stayed longer than 11.3 days in hospital. The treatment decision (hemi-arthroplasty vs. total hip arthroplasty) was not associated with a exceptionally long length of stay: pulmonary embolism and an acute myocardial infarction were most strongly associated (Table 3).

Inpatient Death

The inpatient death rate was 1.2% (1009 patients). The factor most strongly associated with inpatient death in the regression analysis was intubation/mechanical ventilation (Table 4). The type of arthroplasty was not related.

Discussion

We are facing an increasing incidence of femoral neck fractures and there is evidence that total hip arthroplasty is a better alternative than hemi-arthroplasty for some patients. Previous studies described lower re-operation

rates, better pain relief and better functional outcome after total hip arthroplasty for femoral neck fracture compared to hemi-arthroplasty (1-3, 5-7). The purpose of our study was to evaluate the in-hospital outcome of isolated femoral neck fracture either treated with a hemi- or total hip arthroplasty. We found that the length of stay and in-hospital mortality were related to medical comorbidities and did not differ between patients treated with a hemi-arthroplasty and patients treated with a total hip arthroplasty, but patients treated with hemi-arthroplasty had a 40% higher risk of inpatient adverse events.

This study must be interpreted in the lights of several limitations. Since the NHDS database only provides inpatient data, this study does not allow an analysis for revision rates, dislocation rates in the long-term and for mortality rates after discharge, like a one-year mortality rate. However, inpatient mortality and morbidity are commonly used parameters in quality of care studies (14). The limitation of information available on these and other outcome variables, like pain relief or functional outcome, may be seen as a shortcoming of this study. Our results are based on information covering only two years (2009 and 2010), and we did not have data on surgeon experience or volume or operative approach. Since we used a large national sample we believe that our data reflect a mean or equal distribution of these parameters and are generalizable to the average surgeon and hospital in the United States.

The higher percentage of complications in patients treated with hemi-arthroplasty is in contrast to a previous meta-analysis and a prospective randomized

Table 3. Predictors of length of stay > mean+2SD after hemi- or total hip arthroplasty for isolated femoral neck fracture* (n = 82591)

Parameter	Significance	Odds ratio	95% confidence interval	
			Lower	Upper
Pulmonary embolism	<0.001	30	20	45
Acute myocardial infarction	<0.001	9,8	8,3	12
Marital status: married	<0.001	7,6	6,0	9,6
Pneumonia	<0.001	4,0	3,3	4,9
COPD or allied condition	<0.001	3,8	3,3	4,3
Atrial fibrillation	<0.001	3,5	3,1	4,0
Nutritional deficiency	<0.001	3,2	2,7	3,8
Transfusion	<0.001	3,2	2,8	3,6
Chronic kidney disease	<0.001	3,1	2,4	4,0
Intubation or mechanical Ventilation	<0.001	0,53	0,42	0,67
Essential hypertension	<0.001	0,37	0,33	0,43
Diabetes	<0.001	0,28	0,23	0,35
Congestive heart failure	<0.001	0,16	0,13	0,19
Chronic ischaemic heart disease	<0.001	0,069	0,055	0,086

n, number of patients in the cohort

* variables included in the regression: sex, marital status, essential hypertension, hypertensive disease, atrial fibrillation, chronic ischaemic heart disease, congestive heart failure, COPD, chronic kidney disease, diabetes, nutritional deficiency, pulmonary embolism, pneumonia, intubation or mechanical ventilation, acute myocardial infarction, conversion to cardiac rhythm, acute kidney disease, posthaemorrhagic anemia, transfusion

study in which comparable complication rates were found in both groups (1, 15). One study even found a higher general complication rate in patients treated with a total hip arthroplasty, and another indicates a lower likelihood of developing respiratory complications after

hemiarthroplasty (3, 9). We suspect that there is some kind of selection bias (more ill patients getting a hemiarthroplasty, more complications) that ICD-9 coding of comorbidities cannot account for. In other words, large database studies can't measure the inherent differences

Table 4. Predictors of in-hospital death after hemi- or total hip arthroplasty for isolated femoral neck fracture* (n = 82591)

Parameter	Significance	Odds ratio	95% confidence interval	
			Lower	Upper
Intubation or mechanical ventilation	<0.001	247	168	363
Chronic ischaemic heart disease	<0.001	37	23	60
Marital status: married	<0.001	4,3	3,6	5,1
Pneumonia	<0.001	3,8	2,5	5,9
COPD or allied condition	<0.001	3,0	2,5	3,6
Days of care	<0.001	1,1	1,1	1,1
Age	<0.001	1,0	1,0	1,1
Acute myocardial infarction	<0.001	0,22	0,14	0,35
Essential hypertension	<0.001	0,20	0,16	0,26
Transfusion	<0.001	0,17	0,12	0,22

n, number of patients in the cohort

* variables included in the regression: age, marital status, days of care, essential hypertension, atrial fibrillation, chronic ischaemic heart disease, congestive heart failure, COPD, chronic kidney disease, diabetes, malignancy, nutritional deficiency, pulmonary embolism, pneumonia, intubation or mechanical ventilation, acute myocardial infarction, conversion to cardiac rhythm, posthaemorrhagic anemia, transfusion

between two procedures that is better measured by a randomized trial. But a large database study is well suited to measuring what happens on average in actual practice.

The present study found adverse events such as pulmonary embolism, acute myocardial infarction and pneumonia are the greatest predictors for a longer hospital stay. Previous studies have also described postoperative adverse events as risk factors associated with prolonged hospital stay after total hip arthroplasty for osteoarthritis. However, they also found other variables with significant influence on length of stay, such as female sex, increasing age, and comorbidities (16).

This large database study is consistent with other types of studies in finding no differences in inpatient mortality rate after either a hemi-arthroplasty or a total hip arthroplasty. Other studies found no differences in death rate after 30 days, one-year, or more than one year (1, 2, 6-11). The Danish NHDR database described comorbidities like COPD, cardiac failure, dementia and diabetes as the greatest predictors for death after arthroplasty for a femoral neck fracture (17). In our study intubation or mechanical ventilation and chronic ischemic heart disease were found to be the greatest

predictors of death. In contrast to previous studies male sex did not influence the mortality risk, which may reflect differences in study types or cultural differences (14, 17).

This large national database study found that—in the United States in 2009 and 2010 hemi-arthroplasty was associated with greater inpatient adverse events, but not greater length of stay or inpatient mortality compared to total hip arthroplasty for femoral neck fracture. In our opinion, this most likely reflects the use of hemiarthroplasty in more infirm patients in a way that is not captured entirely by ICD-9 codes for comorbidities.

Acknowledgements

Each author was involved in the collecting of data, searching of literature, and writing of the article.

Timothy Voskuyl MD

Valentin Neuhaus MD

Ahmet Kinaci BSc

Mark Vrahas MD

David Ring MD PhD

Massachusetts General Hospital, Yawkey Center, Suite 2100, 55 Fruit Street, Boston, MA 02114, USA

References

- Burgers PT, Van Geene AR, Van den Bekerom MP, Van Lieshout EM, Blom B, Aleem IS et al. Total hip arthroplasty versus hemiarthroplasty for displaced femoral neck fractures in the healthy elderly: a meta-analysis and systematic review of randomized trials. *Int Orthop.* 2012; 36(8):1549-60.
- Carroll C, Stevenson M, Scope A, Evans P, Buckley S. Hemiarthroplasty and total hip arthroplasty for treating primary intracapsular fracture of the hip: a systematic review and cost-effectiveness analysis. *Health Technol Assess.* 2011; 15(36):1-74.
- Hopley C, Stengel D, Ekkernkamp A, Wich M. Primary total hip arthroplasty versus hemiarthroplasty for displaced intracapsular hip fractures in older patients: systematic review. *BMJ.* 2010; 340:2332.
- Keating JF, Grant A, Masson M, Scott NW, Forbes JF. Displaced intracapsular hip fractures in fit, older people: a randomised comparison of reduction and fixation, bipolar hemiarthroplasty and total hip arthroplasty. *Health Technol Assess.* 2005; 9(41):1-65.
- Liao L, Zhao Jm, Su W, Ding Xf, Chen Lj, Luo Sx. A meta-analysis of total hip arthroplasty and hemiarthroplasty outcomes for displaced femoral neck fractures. *Arch Orthop Trauma Surg.* 2012; 132(7): 1021-9.
- Yu L, Wang Y, Chen J. Total hip arthroplasty versus hemiarthroplasty for displaced femoral neck fractures: meta-analysis of randomized trials. *Clin Orthop Relat Res.* 2012; 470(8):2235-43.
- Zi-Sheng A, You-Shui G, Zhi-Zhen J, Ting Y, Chang-Qing Z. Hemiarthroplasty vs primary total hip arthroplasty for displaced fractures of the femoral neck in the elderly: a meta-analysis. *J Arthroplasty.* 2011; 27(4):583-90.
- Avery PP, Baker RP, Walton MJ, Rooker JC, Squires B, Gargan MF, et al. Total hip replacement and hemiarthroplasty in mobile, independent patients with a displaced intracapsular fracture of the femoral neck: a seven- to ten-year follow-up report of a prospective randomised controlled trial. *J Bone Joint Surg Br.* 2011; 93(8):1045-8.
- Fisher MA, Matthei JD, Obirize A, Ortega G, Tran DD, Carnegie DA, et al. Open reduction internal fixation versus hemiarthroplasty versus total hip arthroplasty in the elderly: a review of the National Surgical Quality Improvement Program database. *J Surg Res.* 2013; 181(2):193-8.
- Parker MJ, Gurusamy K. Internal fixation versus arthroplasty for intracapsular proximal femoral fractures in adults. *Cochrane Database Syst Rev.* 2006; 4:CD001708.
- Parker MJ, Handoll HH. Replacement arthroplasty versus internal fixation for extracapsular hip fractures in adults. *Cochrane Database Syst Rev.* 2006; 2: CD000086.

12. Lemeshow S, Teres D, Klar J, Avrunin JS, Gehlbach SH, Rapoport J. Mortality Probability Models (MPM II) based on an international cohort of intensive care unit patients. *JAMA*. 1993; 270(20): 2478-86.
13. Memtsoudis SG, González Della Valle A, Besculides MC, Gaber L, Sculco TP. In-hospital complications and mortality of unilateral, bilateral, and revision TKA: based on an estimate of 4,159,661 discharges. *Clin Orthop Relat Res*. 2008; 466(11):2617-27.
14. Neuhaus V, King J, Hageman MG, Ring DC. Charlson Comorbidity Indices and In-hospital Deaths in Patients with Hip Fractures. *Clin Orthop Relat Res*. 2013; 471(5):1712-9.
15. Baker RP, Squires B, Gargan MF, Bannister GC. Total

- hip arthroplasty and hemiarthroplasty in mobile, independent patients with a displaced intracapsular fracture of the femoral neck. A randomized, controlled trial. *J Bone Joint Surg Am*. 2006; 88(12):2583-9.
16. Vorhies JS, Wang Y, Herndon J, Maloney WJ, Huddleston JI. Readmission and length of stay after total hip arthroplasty in a national Medicare sample. *J Arthroplasty*. 2011; 26: 119-23.
 17. Kannegaard PN, van der Mark S, Eiken P, Abrahamsen B. Excess mortality in men compared with women following a hip fracture. National analysis of comedication, comorbidity and survival. *Age Ageing*. 2010; 39(2):203-9.

* Appendix A. ICD-9 codes for variables used in this study

Variables	Corresponding ICD-9 codes
Injury	
Transcervical fracture of femoral neck	820.00-820.19
Treatment	
Total hip arthroplasty	81.51
Hemi arthroplasty	81.52
Comorbidities	
Essential hypertension	401
Hypertensive disease	402, 403, 404, 405
Atrial fibrillation	427.3
Angina Pectoris	413
Other chronic ischaemic heart diseases	414
Congestive heart failure	428
Chronic deep venous thrombosis lower limb	453.5
Chronic pulmonary disease (COPD or allied condition)	490, 491, 492, 493, 494, 495, 496
Chronic kidney disease (any stage)	585
Chronic liver disease	571
Diabetes	250
Osteoporosis	733
Malignancy	140-208, 230-234
Nutritional deficiency	260-269
Dementia	290
Chronic Alcoholism	303.9
Obesity	278

Complications	
Hemorrhage or haematoma	998.1
Wound complication	998.3
Postoperative infection / inflammation	998.5, 996.6
Acute deep venous thrombosis lower limb	453.4
Pulmonary embolism	415.1
Pneumonia	482, 485, 486
Other complications respiratory system	514, 518.4518.5, 518.7, 518.8
Intubation or mechanical ventilation	96.04, 96.07, 96.7, 93.90
Acute myocardial infarction	410
Other (sub)acute ischaemic cardial events	411
Ventricular arrhythmias or cardiac arrest	427.4, 427.5
Conversion of cardiac rhythm	99.6
Acute cystitis	595.0
Acute renal failure	580, 584
Mechanical complication of internal orthopedic device	996.4
Non-mechanical complication of internal orthopedic device	996.78
Acute post-hemorrhagic anemia	285.1
Iatrogenic post-operative hypotension	458.29
Post-operative shock	998.0
Transfusion of blood(components)	99.0
(transient) induced mental disorder	293

* Four- and five-digit codes are included under the respective three and four-digit codes. Additional coding information <http://www.findacode.com/>