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Mortality rates of humerus fractures in the elderly: does surgical treatment matter?

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Abstract

Introduction—Multiple studies have shown the impact of hip fractures on geriatric mortality. Few evaluate mortality after proximal (PH) or distal humerus (DH) fractures, and fewer determine differences in mortality based on management. We aim to evaluate a statewide cohort of elderly patients with PH or DH fractures to evaluate mortality, length of stay (LOS), discharge data, readmission and evaluate differences based on management.

Methods—The NY Statewide Planning and Research Cooperative System (SPARCS) database was used to identify patients 60 years and older admitted with a PH or DH fracture. Patient demographics, including age, gender, sex, race, weight, and insurance status, along with comorbid conditions using the Charlson Comorbidity Index, were determined. Seven-day, 30-day and 1-year mortality was determined for operative and non-operative cohorts. Logistic regression determined the competing risk of mortality when controlling for patient demographics, comorbid conditions, and treatment.

Results—42,511 PH and 7,654 DH fractures were evaluated. PH fractures had higher mortality than DH. Non-operative treatment occurred in 76.2% of PH fractures and 53% DH fractures. There were more comorbid conditions, longer length of stay, and higher mortality at 7 days, 30 days, and 1 year in patients treated non-operatively. After controlling for patient demographics and comorbid conditions, there was no difference in mortality between PH and DH fractures, but operative treatment for either PH or DH was associated with lower mortality at all time points.

Discussion—Fewer PH than DH fractures were treated operatively. Operative treatment was associated with improved survival in patients hospitalized with PH or DH fracture even after controlling for patient demographic and comorbid factors.

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Introduction

Fractures of the humerus may occur from high-energy mechanisms, low-energy injuries such as a ground-level fall, or from pathologic processes such as metastatic disease or Paget's disease of bone. In elderly patients, proximal humerus (PH) fractures are the third most common fracture pattern. In geriatric females, 95% of all proximal humerus fractures are caused by falls from standing height (1). The incidence of proximal humeral fractures in geriatric population has increased by 28% between 1990 and 2010 (2). Although less common than PH fractures, fractures of the distal humerus (DH) occur from a similar mechanism and are projected to increase threefold by 2030(3).

Following hip fracture in the elderly, the associated mortality rate, and the benefits of surgical treatment have been well studied and defined in the literature (4–10). However, little attention has been directed at mortality relating to surgical treatment of PH and DH fractures. Humeral fractures, whether proximal or distal, significantly impact an elderly patient's activities of daily living (ADLs) (11), and a decline in functional status and activity level can lead to overall physical deconditioning. Although some studies have found no significant clinical difference in patient reported outcomes between those treated operatively and non-operatively, surgical treatment is increasing (12, 13). With regards to mortality, a recent meta-analysis found little difference in mortality between operative and non-operative treatment in 496 patients (14).

Given the similarity in mechanism in which geriatric patients sustain low-energy fractures, we hypothesized patients with PH and DH fractures would have mortality rates that were significant, but lower mortality than the reported mortality following geriatric hip fracture. Our secondary hypothesis was that mortality rates for PH and DH fractures would be altered by surgical treatment.

Methods

The New York Statewide Planning and Research Cooperative System (SPARCS) database is a comprehensive database that collects information for every individual patient in the entire state of New York. The database includes patient demographics, diagnoses, procedures, and charges for every inpatient hospital admission, ambulatory surgical procedure, and emergency department visits in the state of New York. Each patient has a unique identification code which allow for longitudinal analyses. Estimated reporting completeness obtained from SPARCS inpatient annual reports during the study period (2000–14) ranged from 95% to 100%, with an average of more than 98% (15). SPARCS was utilized to identify patients aged 60 years or older admitted between January 1, 2000 and December 31, 2014 with a PH or DH fracture. Patients were excluded if they were younger than 60 years of age, had concomitant proximal and distal humerus fracture, sustained a mid-shaft humerus fracture, or were missing the unique personal identifier (encrypted combination of name, date of birth, social security number, hospital, and date of admission). Mortality following fracture was determined at 7-days, 30-days, and 1-year from date of admission using a linkage with the New York State Department of Vital Statistics and New York City Department of Vital Statistics.

Patients were identified from inpatient hospital discharge records containing an ICD-9-CM code for proximal humerus fracture (812.10, 812.11, 812.12,812.13, 812.19) or distal humerus fracture (812.50,812.51,812.52,812.53,812.54,812.59). ICD-9 procedure codes were utilized to determine patients who were treated operatively (7901, 7911, 7921, 7931). Patients with multiple humerus fracture codes or multiple records were excluded. Comorbidities were identified from discharge billing data based on ICD-9-CM codes and defined using the Charlson Comorbidity Index (CCI).

Statistical analysis

Differences between categorical groups were assessed with Chi-Square analysis and between continuous variables with Student's T-test. Survival estimates were determined with the Kaplan-Meier method. Logistic regression was utilized to evaluate the risk of mortality from individual variables while controlling for age, gender, race, weight, insurance status, readmission status, fracture status (open or closed), patient disposition, and comorbid conditions.

Results

The results are listed in Tables 1–4 and in the Supplemental Digital Content. As expected, there were more admissions with PH than DH fractures. PH fractures had higher overall mortality rates at all time points (Table 1).

Demographics and treatment characteristics of patients with PH fractures are shown in Table 2. Most patients with PH fracture were treated non-operatively, and those treated non-operatively were older and had higher average Charlson comorbidity count. Those treated operatively had shorter length of stay, higher rate of discharge to home, lower readmission rate, and lower mortality rates at all time points than those treated non-operatively. A larger percentage of DH fractures, compared to PH fractures, were treated operatively (Table 3). DH fractures treated operatively also had shorter length of stay, fewer comorbid conditions, higher rate of discharge to home, and lower readmission and mortality rates.

Operatively treated patients, regardless of PH or DH location, were similar in terms of age and length of stay (See Table, Supplemental Digital Content 1, which compares characteristics of operatively treated DH and PH fractures). However, patients with DH fracture treated operatively had slightly higher rates of discharge to home than those with PH fracture. Length of stay and mortality rates were similar in non-operatively treated DH and PH fractures (See Table, Supplemental Digital Content 2, which compares characteristics of non-operatively treated DH and PH fractures).

To account for differences in demographics and comorbidity status, logistic regression analysis was used to evaluate the effect of operative treatment on 1-year (Table 4), 30 day (See Table, Supplemental Digital Content 3), and 7-day (See Table, Supplemental Digital Content 4) survival in PH and DH fractures. After controlling for multiple variables (age, gender, race, length of stay, weight, health insurance status, disposition, and comorbid conditions), operative treatment remained associated with reduced mortality at 7 days, 30

days, and 1-year. Metastatic carcinoma, liver disease, cancer, congestive heart failure, and age over 80 were associated with the most elevated odds of 1-year mortality.

On Kaplan-Meier analysis, operative PH and DH cohorts had similar survival while survival after non-operative PH and DH fractures decreased more rapidly early after injury than for operative fractures. PH fractures managed non-operatively had the lowest probability of survival (Figure 1).

Discussion

This is the first study to determine risk of mortality after hospitalization for PH and DH fractures in a large population. The population studied is more than 100-fold larger than that evaluated in a 2015 Cochrane review (14) and found a different result. Despite controlling for patient age, gender, sex, race, weight, insurance status comorbid status, there remained a significant mortality benefit to operative treatment of proximal and distal humerus fractures in patients admitted to the hospital in New York State across a 15-year period.

Multiple studies have documented a relationship between PH fracture mortality rate and age, with 1-year mortality around 7% in patients over age 50 and 10% over the age of 65 (16–19). Compared with these prior studies, which did not only include those admitted to the hospital our results suggest the mortality rate is higher than previously appreciated in the cohort of patients requiring admission. These results are striking in comparison to the hip fracture population; 1 year mortality after hip fracture ranges from 12% to 37% (8–10,20). In contrast, this study found a 1-year mortality rate of 14.4% to 17.2% in patients admitted to the hospital with PH or DH fracture.

The results of this study suggest DH fractures carry a better prognosis regardless of treatment when compared to PH fractures when considering mortality. However, regardless of fracture location, there was an increase in 30-day readmission rates, and 7-day, 30-day and 1-year mortality rates for non-operatively managed humerus fractures. The differences in management and mortality rates are potentially related to selection bias for surgery including the patient’s age, functional status and medical comorbidities. This study found that non-operatively treated patients were older, less likely to be discharged to home and had, on average, more comorbid conditions than those treated operatively. However, when controlling for age, gender, insurance status, comorbid conditions, operative treatment remained protective against mortality. It is possible that factors not accounted for in administrative data impacted individual surgeon and patient decisions about operative treatment. However, a notable finding in this study is that, similar to the hip fracture literature, non-operative treatment is associated with increased mortality rates.

In this study, females made up >75% of the humeral fracture population, it is unclear whether osteoporosis screening programs are adequately identifying females with poor bone quality and upper extremity fracture risk and directing them toward appropriate bone metabolic workup and intervention. It is possible that refinements in screening and prevention programs could decrease the incidence of PH and DH fractures.

This study is based on billing data from New York State and may not be generalizable to populations in other states or countries. Inherent to billing databases there exists the possibility of incomplete or inaccurate coding of data including diagnoses, comorbid conditions, or location of the fracture. Although there is a strong association with geriatric fractures and osteoporosis, our analysis does not include objective measures of bone density (21). Practice patterns in terms of operative versus non-operative intervention likely evolved over the course of the study period but due to inability to evaluate each patient's fracture pattern and health profile individually, it is not possible to evaluate whether changes in individual treatment decisions affected the risk of mortality. Efforts were made to limit the study to low-energy mechanisms by exclusion of patients with billing codes suggesting poly-trauma; nevertheless this study design did not permit evaluation of the mechanism or degree of energy contributing to the fracture or fracture patterns. By limiting the study to patients with an inpatient hospitalization, these results may be less valid for healthier, community ambulators who did not require hospitalization, while increasing applicability for patients requiring hospital admission.

The risk of mortality after hip fracture is well documented, and this study suggests a similarly high risk of mortality after hospitalization for PH or DH in patients over 60 years of age. Additionally, this study found that operative treatment of humeral fractures was associated with improved 1-year survival even after accounting for multiple patient factors. We believe the ultimate decision to operate or not should be based on patient health and preferences, fracture characteristics, and surgeon experience. The findings of the study can help guide discussions with patients and their family in regards to risks of mortality following proximal or distal humerus fracture.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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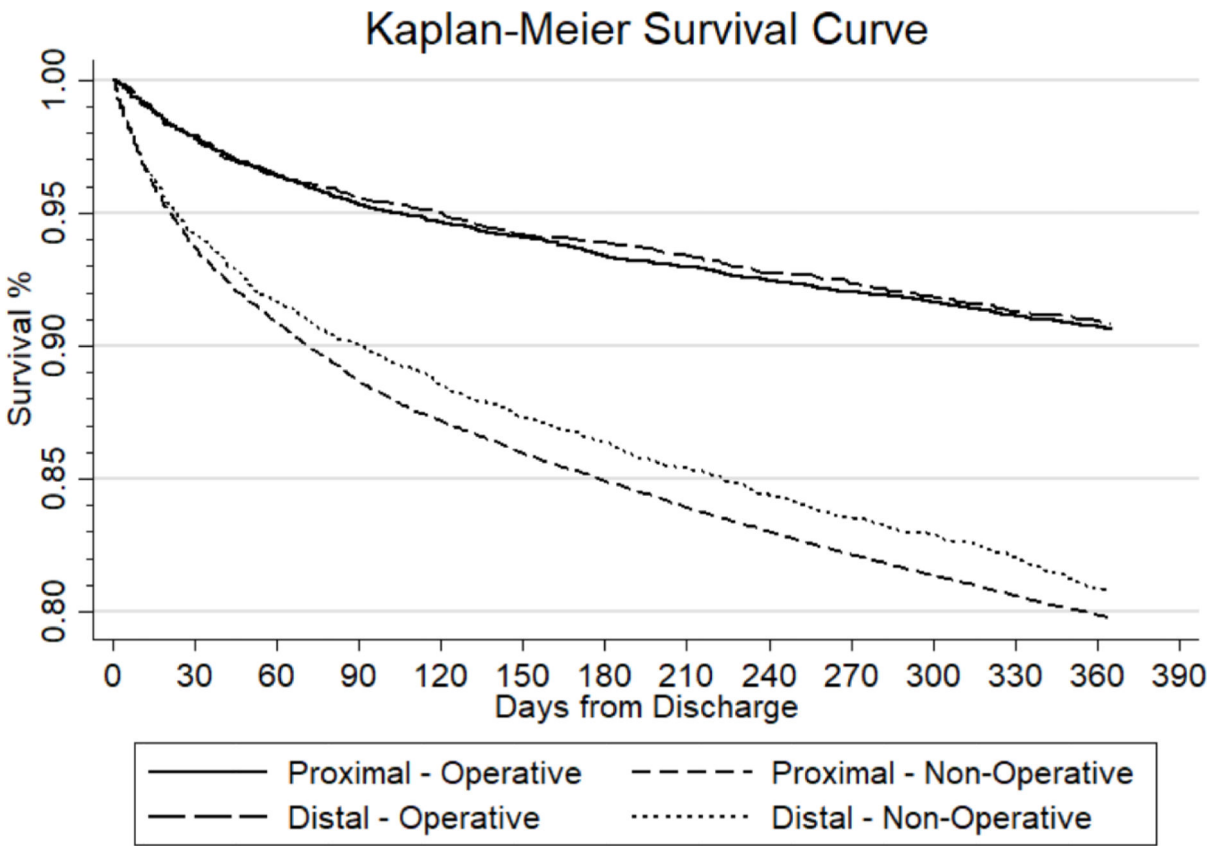

Figure 1.
Kaplan-Meier Survival Curve Operative vs. Non-operative

Table 1:

Proximal vs. Distal Humerus Fracture Mortality Rates

	Proximal Humerus	Distal Humerus	P-Value
Mortality <7 days	808 (1.9%)	114 (1.5%)	0.01
Mortality <30 days	2316 (5.4%)	325 (4.2%)	<0.01
Mortality 1 year	7,377 (17.4%)	1,102 (14.4%)	<0.01

Table 2:

Proximal Humerus Fracture Operative vs. Non-operative Management

	Proximal Humerus (N=42,511)		
	Operative N = 10,132 (23.8%)	**Non-operative N = 32,379 (76.2%)**	**P-Value**
Female Sex (%)	75%	77%	0.30
Mean Age (years)	75.7	80.2	<0.01
Comorbid conditions *	0.82	1.21	<0.01
Length of Stay (# of Day)	6.1	7.3	<0.01
Discharged to home	3,855 (38.0 %)	6,815 (21.0 %)	<0.01
30 Day Readmission	1,358 (13.4%)	5,457 (16.9%)	<0.01
Mortality <7 days (rate)	64 (0.6%)	744 (2.3%)	<0.01
Mortality <30 days (rate)	224 (2.2%)	2,092 (6.5%)	<0.01
Mortality 1 year (rate)	927 (9.1%)	6,450 (19.9%)	<0.01

*Average number of Charlson comorbidities.

Table 3:

Distal Humerus Fracture Operative vs. Non-operative Management

	Distal Humerus (N=7,654)		
	Operative N = 3,600 (47.0%)	**Non-operative N = 4,054 (53.0%)**	**P-Value**
Female Sex (%)	79%	76%	<0.01
Mean Age (years)	75.8	79.2	0.26
Comorbid conditions *	0.86	1.12	<0.01
Length of Stay (# of Days)	6.3	6.9	<0.01
Discharged to home	1,552 (45.1%)	1,294 (31.9%)	<0.01
30 Day Readmission	482 (13.4%)	825 (20.4%)	<0.01
Mortality <7 days (rate)	17 (0.5%)	97 (2.4%)	<0.01
Mortality <30 days (rate)	77 (2.1%)	248 (6.1%)	<0.01
Mortality 1 year (rate)	326 (9.1%)	776 (19.1%)	<0.01

*Average number of Charlson comorbidities.

Table 4:

Multivariate logistic regression analysis of risk factors for 1-year mortality after PH or DH fracture*

	Odds ratio	95% confidence interval		P-Value
Distal humerus	1.01	0.94	1.09	0.7
Age 70–79	1.48	1.34	1.64	0
Age 80–89	2.41	2.18	2.66	<0.001
Age>90	5.23	4.69	5.84	<0.001
Length of stay**	1.02	1.018	1.024	<0.001
Female gender	0.68	0.64	0.72	<0.001
Black race	0.91	0.79	1.04	0.2
Other race	0.86	0.78	0.94	0.002
Open fracture	1.05	0.84	1.31	0.7
Operative treatment	**0.62**	**0.58**	**0.67**	**<0.001**
Obese	0.44	0.35	0.55	<0.001
Morbidly obese	0.70	0.54	0.90	0.005
Medicare coverage	1.13	1.02	1.26	0.02
Medicaid coverage	0.74	0.77	1.16	0.6
Readmission within 30 days	1.89	1.77	2.01	<0.001
Discharge to SNF	0.72	0.68	0.76	<0.001
Discharge to home	0.35	0.32	0.38	<0.001
Acute MI	1.31	1.20	1.44	<0.001
CHF	2.26	2.11	2.41	<0.001
PVD	1.27	1.12	1.44	<0.001
Cerebrovascular disease	1.32	1.20	1.45	<0.001
Dementia	1.57	1.40	1.78	<0.001
Chronic pulmonary disease	1.55	1.45	1.65	<0.001
Rheumatologic disease	1.15	0.99	1.33	0.06
Peptic Ulcer Disease	1.18	0.92	1.52	0.2
Mild liver disease	3.3	2.59	4.20	<0.001
Diabetes mellitus without complication	1.04	0.98	1.11	0.2
Diabetes mellitus with chronic complication	1.23	1.06	1.44	0.007
Hemiplegia or paraplegia	1.95	1.43	2.64	<0.001
Renal disease	1.68	1.55	1.83	<0.001
Cancer	2.94	2.60	3.32	<0.001
Moderate or severe liver disease	6.68	4.82	9.25	<0.001
Metastatic carcinoma	16.27	13.48	19.64	<0.001

*Odds ratios based on comparison to patients in study with the following characteristics: proximal humerus fracture, age 60–69, length of stay=1 day, male, white race, closed fracture, non-operative treatment, non-obese, private insurance, no readmission within 30 days, discharge other than home or skilled nursing facility, no comorbid conditions.

**Incremental length of stay for each additional day beyond 1