



Treatment choice affects inpatient adverse events and mortality in older aged inpatients with an isolated fracture of the proximal humerus



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Background: This study tests the null hypothesis that, among patients aged 65 and older admitted to a United States hospital with an isolated fracture of the proximal humerus (no other injuries or fractures), there are no differences between operative (fixation or arthroplasty) and nonoperative treatments with respect to inpatient adverse events, inpatient mortality, and discharge to a long-term care facility rates accounting for comorbidities.

Methods: Using a large national database representing an estimated 132,005 patients aged 65 and older admitted to a US hospital with an isolated proximal humerus fracture between 2003 and 2007. Sixty-one percent did not have surgery, 22% were treated with open reduction and internal fixation (ORIF), and 17% were treated with arthroplasty.

Results: The risk of an in hospital adverse event was 21% overall and was 4.4 times greater with arthroplasty and 2.7 times greater with ORIF compared to nonoperative treatment. The risk of in hospital death was 1.8% overall and was 2.8 times greater with ORIF compared to nonoperative treatment. Patients treated operatively were less likely to be discharged to a long-term facility compared to patients treated nonoperatively.

Conclusion: In spite of a tendency to treat the most infirm patients (those that are not discharged to home) nonoperatively, operative treatment (open reduction and internal fixation in particular) is an independent risk factor for inpatient adverse events and mortality in older-aged patients admitted to the hospital with an isolated fracture of the proximal humerus and should perhaps be offered more judiciously.

Level of evidence: Level III, Retrospective Cohort Study, Treatment Study.

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Keywords: Comorbidity; complication; operation; proximal humerus fracture; surgery; arthroplasty; open reduction and internal fixation

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Many factors influence the decisions between operative and nonoperative treatment and between internal fixation (IF) and arthroplasty in the management of fractures of the proximal humerus. Fracture pattern, displacement, osteoporosis, and the risk of avascular necrosis are commonly discussed influences on the decision process.^{6,10,12,20,22,23,26} However, the inter- and intraobserver reliability of some of these parameters are low.^{4,17} The influence of the patient's pre-injury infirmity and functional demands on treatment decisions and outcome is less well-studied.^{14,20,21} In one recent study, nearly 90% of patients aged 60 or greater with a displaced proximal humerus fracture had important medical comorbidities and the Charlson Index (used to estimate 1-year mortality in hospitalized patients) was associated with the use of arthroplasty rather than internal fixation.²⁰ Factors associated with nonoperative treatment of fractures of the proximal humerus in prior studies include: fracture type, age greater than 70-85, limited functional demands, cognitive impairment, severe comorbidities such as malignancy or diabetes mellitus, a higher Charlson comorbidity Index score, smoking and alcoholism.^{7,8,20,23}

The purpose of this study was to use a large database of inpatients with an isolated proximal humerus fracture to determine predictors of adverse events, inpatient death, and discharge to a long-term facility. Specifically, we tested the null hypothesis that among inpatients with an isolated fracture of the proximal humerus, and accounting for comorbidities, there are no differences between nonoperative and operative (IF or arthroplasty) treatment with respect to inpatient adverse events, inpatient death, or discharge to a long-term facility.

Materials and methods

Data were obtained from the National Hospital Discharge Survey (NHDS), provided by the National Center for Health Statistics.⁹ The NHDS covers discharges from a spectrum of representative hospitals across the country, not including federal, military, and United States Department of Veterans Affairs hospitals. Only short-stay, nonspecialty hospitals (average length of stay less than 30 days) are included in the survey. These hospitals must also have a minimum of 6 beds staffed for patient use. Each year, approximately 1% of total hospital admissions in the United States are abstracted and weighted to represent all such hospital discharges nationwide. Information collected from hospital records includes sex, age, up to 7 diagnoses, up to 4 procedures performed during hospitalization, length of hospital stay, and discharge status.

We identified patients aged 65 and older admitted to a hospital in the United States with an isolated acute proximal humerus fracture, treated either nonoperative or operative with IF or (total and hemi-)arthroplasty, based on the International Classification of Diseases, 9th Revision, Clinical Modification from the NHDS database between 2003 and 2007. We excluded all patients with concomitant injuries, fractures, or concomitant procedures, identified via other injury ICD-9 diagnoses (800-869) and codes for bony procedures (76, 78, 79, 81, 82), in order to study the

relationship of the treatment and the adverse events related solely to a proximal humerus fracture. We used ICD-9 codes to identify comorbidities, procedures and adverse events (surgery-related as well as general) after procedures (see addendum for ICD-9 codes).^{5,19} The cohort included an estimated 132,005 patients, 85% women with a mean age of 79 years. Sixty-one percent did not have surgery, 22% were treated with IF, and 17% were treated with arthroplasty (Table I). Patients treated with IF were significantly younger (75 ± 7.2 years) than patients treated with arthroplasty (78 ± 7.1 years) or nonoperative treatment (81 ± 7.4 years, $P < .001$). Patients who underwent arthroplasty had more comorbidities (74%) than patients treated with IF (70%), but less than patients treated nonoperatively (79%, $P < .001$). The most common comorbidities were hypertension (45%) and diabetes mellitus (20%) (Table II). The length of stay averaged 4.5 ± 4.1 days.

Statistical analysis

Our response variables were inpatient adverse events, inpatient death, and discharge to a long-term facility. Explanatory variables included demographic patient data, pre-existing comorbidities, treatment (nonoperative vs IF vs arthroplasty), and new inpatient comorbidities. Continuous data were presented as mean \pm standard deviation (\pm SD). We assumed normality based on our large sample size. Unpaired *t* tests were performed to determine the differences between two continuous variables and ANOVA between three continuous variables. Pearson chi-square tests were used to analyze differences between two categorical variables. Wherever the minimum expected cell frequency was less than 5, the Fisher's exact test was used instead. For each response variable, explanatory variables $P < .001$ (given the large sample size) and an overall occurrence of $\geq 2\%$ ¹⁵ in bivariate analysis were entered into a stepwise backward logistic regression.

Results

Thirty-seven percent of the patients treated with arthroplasty had at least one adverse event, compared to 26% after IF, and 15% after nonoperative treatment ($P < .001$). Transfusion and acute postoperative anemia were significantly more common after arthroplasty (29% and 14%) than after IF (14% and 7.6%) and nonoperative treatment (4.8% and 2.4%, $P < .001$). Acute renal failure and pneumonia were more common in patients treated nonoperatively. Induced mental disorder, iatrogenic hypotension, pulmonary embolism, and pulmonary insufficiency were more common in patients undergoing arthroplasty (Table III). In multivariable analysis arthroplasty and IF were associated with a greater risk of an inpatient adverse event (OR = 4.4, 95% CI 4.3-4.6 and OR = 2.7, 95% CI 2.6-2.8, respectively) (Table IV).

Patients treated with IF had a significantly higher inpatient death rate of 2.3%, compared to 0.4% in the arthroplasty group and 2.0% in the nonoperative group ($P < .001$). IF was an independent risk factor for inpatient death (OR = 2.8, 95% CI 2.5-3.8) (Table V). Malignancy, acute renal failure, pneumonia, male sex, older age, and longer hospital stay were the other predictors of death

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