



Obesity is associated with increased postoperative complications after operative management of proximal humerus fractures

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Background: Obesity has become a significant public health concern in the United States. The goal of this study was to assess the effect of obesity on postoperative complications after operative management of proximal humerus fractures by use of a national database.

Methods: Patients who underwent operative management of a proximal humerus fracture were identified in a national database by *Current Procedural Terminology* codes for procedures in patients with *International Classification of Diseases, Ninth Revision* (ICD-9) codes for proximal humerus fracture, including (1) open reduction and internal fixation, (2) intramedullary nailing, (3) hemiarthroplasty, and (4) total shoulder arthroplasty. These groups were then divided into obese and nonobese cohorts by use of ICD-9 codes for obesity, morbid obesity, or body mass index >30. Each cohort was then assessed for local and systemic complications within 90 days and mortality within 2 years postoperatively. Odds ratios and 95% confidence intervals were calculated.

Results: From 2005 to 2011, 20,319 patients who underwent operative management of proximal humerus fractures were identified, including 14,833 (73.0%) open reduction and internal fixation, 1368 (9.2%) intramedullary nail, 3391 (16.7%) hemiarthroplasty, and 727 (3.6%) shoulder arthroplasty. Overall, 3794 patients (18.7%) were coded as obese, morbidly obese, or body mass index >30. In each operative group, obesity was associated with a substantial increase in local and systemic complications.

Conclusions: Obesity and its resultant medical comorbidities are associated with increased rates of postoperative complications after operative management of proximal humerus fractures. Obese patients for whom operative management of proximal humerus fractures is planned should be counseled preoperatively about their increased risk for postoperative complications.

Level of evidence: Level III, Retrospective Cohort Design from Large Database, Treatment Study.

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Keywords: Proximal humerus fracture; obesity; open reduction and internal fixation; humeral intramedullary nail; hemiarthroplasty; reverse total shoulder arthroplasty

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Proximal humerus fractures in the elderly population are the third most common fracture type and consequently represent a significant socioeconomic burden.^{5,17} Treatment of these injuries remains challenging, and the optimal management and expected outcomes of displaced proximal humerus fractures vary on the basis of the characteristics of the fracture and the patient, including but not limited to the number of parts to the fracture, predicted viability of the head fragment, and bone quality of the patient.⁷⁷

Fortunately, the majority of proximal humerus fractures are nondisplaced or minimally displaced, for which good to excellent outcomes can be expected with nonoperative management.¹⁶ Operative management is often chosen for Neer 3- or 4-part fractures.⁷⁶ During the past 15 years, there has been significant literature reporting the outcomes and complications of a variety of surgical treatment options, including osteosynthesis by open reduction and internal fixation (ORIF) with locked plating or intramedullary (IM) nailing, humeral head hemiarthroplasty, and reverse total shoulder arthroplasty (RTSA).^{7,12,14,19,22,40,45,51,61,63,74,77,91,96,100,114,118}

Although significant advances have been made in the operative management of proximal humerus fractures, complications still occur not infrequently. Many complications, both local and systemic, are reported after operative management of proximal humerus fractures. Local complications include deep infection, neurovascular injury, malunion, nonunion, hardware failure, joint stiffness, heterotopic ossification, and avascular necrosis.^{10,12,45,79,91,118} Systemic complications include deep venous thrombosis (DVT), pulmonary embolism (PE), end-organ failure, and nonsurgical site infection such as urinary tract infection or pneumonia.

Obesity has become a significant public health concern in the United States. Obesity has been associated with increased perioperative and postoperative complications after numerous orthopedic procedures, including total hip and knee arthroplasty,^{1,8,21,25,28,29,37,49,52,53,56,62,65,67,72,75,85,92,93,103,104,107} total shoulder arthroplasty,^{31,33,64} spine surgery,^{43,54,66,70,80,84,89,101,102,111} fixation of acetabulum, ankle, and femur fractures,^{47,59,60,69,83,94,99} knee arthroscopy,^{23,97,109} shoulder arthroscopy,^{73,106} and others.^{26,27,30,34,90} Few published data have examined the association between obesity and postoperative complications after operative management of proximal humerus fractures. The objective of this study was to use a national database to assess the effect of obesity and its associated medical comorbidities on postoperative complications after operative management of proximal humerus fractures, including ORIF, IM nailing, hemiarthroplasty, and RTSA.

Materials and methods

All data were derived from a publicly available database of patients, the PearlDiver Patient Records Database (www.pearldiverinc.com;

PearlDiver Inc, Warsaw, IN, USA). The database contains procedure volumes, demographics, and average charge information for patients with *International Classification of Diseases, Ninth Revision* (ICD-9) diagnoses and procedures or *Current Procedural Terminology* (CPT) codes. Data for this study were derived from the Medicare database within the PearlDiver records, which has more than 100 million individual patient records from 2005 to 2011. Access to the database was granted by PearlDiver Technologies for the purpose of academic research. The database was stored on a password-protected server maintained by PearlDiver. CPT and ICD-9 codes can be searched in isolation or in combination with one another. The search results yield the number of patients with the searched code or combination of codes.

For the purposes of this study, the database was queried for a diagnosis of proximal humerus fracture by use of ICD-9 codes 812.00 to 812.03 and 812.09. Four methods of operative management were assessed: ORIF, IM nail, shoulder hemiarthroplasty, and total (assumed to be reverse) shoulder arthroplasty. The associated CPT and ICD-9 codes used to define each operative cohort are listed in [Supplementary Table I](#) (available on the journal's website at www.jshoulderelbow.org). Patients in each operative group were then divided into nonobese and obese cohorts by ICD-9 codes for overweight, obesity, morbid obesity, and body mass index >30 as listed in [Supplementary Table I](#).

The obese and nonobese cohorts for each operative management group were queried for basic demographics including gender, age (<65, 65-80, >80 years), and smoking status. Comorbidities for each cohort were assessed, including diabetes mellitus, obstructive sleep apnea, hyperlipidemia, hypertension, peripheral vascular disease, congestive heart failure, coronary artery disease, chronic kidney disease, chronic lung disease, and chronic liver disease, with ICD-9 codes for each disease.

The obese and nonobese cohorts for each operative management group were then queried for postoperative complications within 90 days after the surgical procedure by use of ICD-9 and CPT codes. The PearlDiver database cannot report patient groups of fewer than 10 patients to remain Health Insurance Portability and Accountability Act (HIPAA) compliant; thus, complications were pooled to yield usable data. Overall complications were queried as "local" and "systemic" complications. Local complications included postoperative stiffness requiring manipulation under anesthesia or lysis of adhesions, diagnosis of postoperative infection, and need for postoperative irrigation and débridement. Systemic complications included PE, DVT, acute myocardial infarction, respiratory failure, acute postoperative cerebrovascular accident, urinary tract infection, pneumonia, and acute renal failure. Postoperative venous thromboembolism (VTE, including PE and DVT) and postoperative infection (including diagnosis and irrigation and débridement) were also separately queried. Mortality within 6 months, 1 year, and 2 years postoperatively was also queried. The associated ICD-9 and CPT codes for each postoperative complication are provided in [Supplementary Table II](#) (available on the journal's website at www.jshoulderelbow.org).

Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for each comparison between obese and nonobese cohorts. χ^2 tests were calculated to determine statistical significance, with $P < .05$ considered significant.

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