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Open reduction internal fixation has fewer short-term complications than shoulder arthroplasty for proximal humeral fractures

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Background: Open reduction and internal fixation (ORIF), hemiarthroplasty (HA), and anatomic or reverse total shoulder arthroplasty (TSA/RTSA) are surgical treatment options for proximal humeral fractures (PHFx). Little is known about comparative complication rates. We aimed to determine whether ORIF for PHFx has fewer 30-day complications than HA and TSA/RTSA and to define independent risk factors for 30-day complications.
Methods: Patients who underwent ORIF, HA, or TSA/RTSA for PHFx between 2006 and 2013 were identified from the National Surgical Quality Improvement Program database. Potential patient and surgical risk factors and 30-day postoperative complications were extracted. Univariate and multivariate analyses were conducted.
Results: We identified 1791 patients (1262 ORIF, 404 HA, and 125 TSA/RTSA). The overall complication rate was 13.0% in ORIF, 22.0% in HA, and 23.2% in TSA/RTSA ($P < .001$), driven primarily by rates of blood transfusion. Multivariate analyses demonstrated ORIF was an independent protective factor against minor complications ($P = .009$) and overall complications ($P = .028$) but not against major complications ($P = .351$). Risk factors for overall complications included preoperative sepsis ($P < .001$), higher American Society of Anesthesiologists Physical Status Classification ($P < .001$), dependent functional status ($P = .002$), transfusion of at least 5 units in the 72 hours before surgery ($P = .002$), longer operative time ($P = .003$), and a history of chronic obstructive pulmonary disease ($P = .028$).
Conclusions: After adjusting for patient factors, ORIF for PHFx remains an independent protective factor against overall complications and minor complications compared with HA and TSA/RTSA, primarily due to lower rates of blood transfusion. Patient comorbidities play a larger role than the procedure selected in predicting short-term complications.
Level of evidence: Level III, Retrospective Cohort Comparison Using Large Database, Treatment Study.

Keywords: Proximal humeral fractures; open reduction and internal fixation; hemiarthroplasty; shoulder arthroplasty

Proximal humeral fractures (PHFx) are increasingly common injuries, especially afflicting elderly osteoporotic patients.[6,15,45] These injuries were responsible for 185,000 emergency department visits in the United States in 2008

Institutional Review Board approval was not necessary for this study because the data were obtained from a deidentified national database.

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alone.[32] Patients experience significant pain and functional loss, particularly for displaced 3-part and 4-part fractures.[41-43] PHFx treatment paradigms are evolving, with available options including nonoperative treatment,[41,42,57] closed reduction and percutaneous pinning,[26,29] open reduction and internal fixation (ORIF),[41,44,51,52] hemiarthroplasty (HA),[42,52] and anatomic and reverse total shoulder arthroplasty (TSA/RTSA).[10-13,16,20,28,33,37,49] RTSA has increasing interest for complex PHFx in elderly patients.[1,31,48]

ORIF, HA, and TSA/RTSA for PHFx have distinct risks and benefits. ORIF preserves bone stock and the potential for anatomic healing, with complications including loss of reduction, screw cutout, intra-articular screw penetration, and avascular necrosis.[44,51,53] HA avoids the complications of ORIF at the expense of glenoid wear, component loosening, and tuberosity nonunion leading to shoulder dysfunction.[4,7,9,23,34,35,47] RTSA simplifies rehabilitation and is less reliant on greater tuberosity healing,[11,20-22] with complications including scapular notching, hematoma, infection, glenoid loosening, and instability.[2,24,25,56]

There is limited and conflicting literature comparing complications among ORIF, HA, and TSA/RTSA for PHFx. Chalmers et al[13] compared 9 patients undergoing each treatment with 1-year follow-up but could not compare complication rates due to the small sample size. A systematic review found overall complication rates of 11.3% for HA, 15% for ORIF, and 18.9% for RTSA.[25] Another systematic review of 14 studies comparing 232 RTSA patients and 263 HA patients reported complication rate that was almost 4-times higher for RTSA (19.4%) than for HA (5.6%), primarily due to higher rates of neurologic injury and ''pain syndrome'' for RTSA.[39] The reoperation rate was 5.8% for the RTSA group and 9.1% for HA group, which was not significant.[39] In contrast, prospective studies comparing HA and RTSA have failed to show a difference in the complication rate.[16,49] The American Board of Orthopaedic Surgery (ABOS) database also showed no difference in the complication rate for HA and RTSA.[1]

The aims of this study were to use the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database (1) to determine whether ORIF for PHFx has fewer 30-day complications than HA and TSA/RTSA after accounting for patient characteristics, (2) to define independent patient and surgical risk factors for 30-day complications after surgical treatment of PHFx, and (3) to analyze trends in surgical management of PHFx from 2006 to 2013 in the United States. We hypothesized that patient comorbidities would be better predictors of risk factors than procedure type for 30-day complications after surgically treated PHFxs. We also hypothesized that between 2006 and 2013, TSA/RTSA would be more frequently used and that HA would be less frequently used.

Materials and methods

Data source and patient selection

The American College of Surgeons NSQIP database contains prospectively collected data for patients who have surgery at more than 400 participating academic and community hospitals in the United States.[14,17,27,36] Surgical Clinical Reviewers (SCRs) at NSQIP hospitals assess hospita]l records to collect defined patient demographics, medical comorbidities, intraoperative data, and 30-day postoperative complications based on criteria specified by the NSQIP program. SCRs undergo specific training from NSQIP and regular audits of SCR interobserver reliability to exclude hospitals with an SCR disagreement rate exceeding 5% or less than 80% 30-day follow-up data (http://site.acsnsqip.org/wp-content/uploads/2014/11/ACS_NSQIP_PUF_User_Guide_2013.pdf).

We queried the NSQIP database to identify all patients undergoing surgical treatment of acute PHFx between 2006 and 2013. The interval was dictated by all years of data available in the NSQIP database, which at the time of analysis were 2006 to 2013. A combination of International Classification of Diseases-9th Revision (ICD-9) codes and Current Procedural Terminology (CPT; American Medical Association, Chicago, IL, USA) codes were used to identify patients undergoing TSA/RTSA, HA, and ORIF for acute PHFx. ORIF was defined as CPT code 23615 or 23630. HA was defined as CPT code 23470 or 23472 combined with one of the following ICD-9 codes: 812.00, 812.01, 812.02, 812.03, 812.09, 812.10, 812.11, 812.12, 812.13, 812.19, 812.20, or 812.30 (online Appendix). TSA/RTSA was defined as CPT code 23472 combined with one of the same ICD-9 codes. Patients with preoperative wound infections and patients aged younger than 18 years were excluded. Patients undergoing closed reduction and percutaneous pinning were excluded because the sample size was too small to allow meaningful comparison.

Data collection

Patient demographics, potential risk factors, and 30-day postoperative complications were extracted from the NSQIP database. Complications were divided into major and minor complications, as previously defined, with death considered a major complication.[38] All of the complications for patients with multiple complications were reported toward individual complication rates, but major, minor, and overall complication rates counted such patients once. Continuous variables were converted to categoric variables: age <30, 30-60, >60 years; operative time <90 or >90 minutes; and BMI <18.5, 18.5-25, 25-30, >30 kg/m^2. The Charlson Comorbidity Index was determined.[8]

Statistical analysis

We performed three separate analyses. To determine trends over time, the number of ORIF, HA, and TSA/RTSA procedures for a given year was divided by the total number of surgeries in the NSQIP database for that year to generate a percentage. Next, the number of patients undergoing HA, ORIF, and TSA/RTSA was divided by the total number of patients undergoing surgical treatment for PHFx. Pearson correlations were used for analysis.