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Thirty-day Complications and Readmission Rates in Elderly Patients After Shoulder Arthroplasty

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Abstract

Introduction: Shoulder arthroplasty procedures are increasingly being performed in older patients despite an increased perioperative risk. The purpose of this study is to determine the complications and 30-day readmission rates in the elderly population after shoulder arthroplasty and hemiarthroplasty.

Methods: Total shoulder arthroplasty, reverse total shoulder arthroplasty, and hemiarthroplasty cases were collected from the National Surgical Quality Improvement Program database from 2006 to 2015. The 30-day complication and readmission rates, surgical time, discharge destination, and total hospital length of stay were calculated, comparing patients by age (elderly: ≥ 80 years; older: 65 to 79 years; younger: < 65 years). Multivariable logistic regression analysis was performed to identify variables associated with any complication within 30 days of surgery.

Results: Of 11,450 patients, 1,956 (17.1%) underwent shoulder hemiarthroplasty and 9,494 (82.9%) underwent total shoulder arthroplasty. By age group, 1,708 (14.9%) were ≥ 80 , 6,073 (53.0%) were 65 to 79, and 3,669 (32.0%) were < 65 . The overall 30-day postoperative complication rate was significantly higher in elderly patients (15.3% versus 8.2% versus 6.8%; $P < 0.001$), length of stay (2.6 versus 2.1 versus 1.8 days; $P < 0.001$), and unplanned readmissions (5.5% versus 2.6% versus 2.3%; $P < 0.001$). The strongest independent variables significantly associated with any complication included revision arthroplasty indication (odds ratio [OR], 4.34; $P < 0.001$), fracture indication (OR, 4.14; $P < 0.001$), and history of cardiac disease (OR, 2.33; $P < 0.001$), followed by elderly age (OR, 2.01; $P < 0.001$).

Conclusions: The 15.3% complication rate (major, 4.8%; minor, 10.7%), 2.6 days of average length of stay, and 5.5% unplanned readmission among elderly patients (> 80) are significantly higher than younger patients. Although surgical indications and comorbidities are higher-quality predictors of complications, elderly patients should be appropriately counseled and medically optimized according to the perioperative risk profile before surgery.

Glenohumeral arthritis is a common disabling condition in the older adult population.¹ After failure of nonsurgical management, total shoulder arthroplasty, reverse shoulder arthroplasty, and hemiarthroplasty are effective procedures with notable improvement in pain and function.^{2,3} Over the past decade, the incidence of shoulder arthroplasty has increased 2.5-fold, and this trend is expected to continue, likely because of an aging population with an expanding Medicare beneficiary group and increased use of reverse shoulder arthroplasty.⁴⁻⁸ Although complications are rare and range between 10% and 16%, they still occur and contribute to notable morbidity and mortality.⁹⁻¹¹

Previous studies have identified perioperative and surgical risk factors markedly associated with increased complications, morbidity, mortality, and readmission rates after shoulder arthroplasty. Some of these variables include increased body mass index, comorbid cardiac disease, vascular disease, tobacco use, perioperative blood transfusion, and insurance status.¹²⁻²⁰ With increased emphasis by the Centers for Medicare and Medicaid Services on value-based reimbursement programs and an overall surgeon concern for improving patient outcomes, it is essential to appropriately risk stratify patients and medically optimize patients before shoulder arthroplasty. This step is especially important in the elderly patient population because of an increased number and severity of medical comorbidities. Therefore, the purpose of this study is to determine the complications and 30-day readmission rates in the elderly population after shoulder arthroplasty. We hypothesized that increasing age would be linearly associated with increased complications and a higher readmission rate.

Methods

After institutional review board deemed this study exempt, we performed a retrospective review of the National Surgical Quality Improvement Program (NSQIP) database for all adult patients who underwent Current Procedural Terminology codes 23470 (ie, shoulder hemiarthroplasty) and 23472 (ie, total shoulder arthroplasty and reverse total shoulder arthroplasty) between January 1, 2006, and December 31, 2015. The American College of Surgeons NSQIP was developed by the Veterans Administration Health System and serves as a centralized database for collection of patient-based variables and surgical outcomes.²¹ Previous research has validated this database as a reliable source for measurement and assessment of surgical outcomes.²² The 2015 NSQIP database was queried and identified 885,502 cases from 603 participating sites.

Exclusion criteria included any patients without appropriate documentation of age in the database. Demographic variables were collected for all patients (Supplemental Table 1, <http://links.lww.com/JG9/A28>). Demographic factors included sex, age, and obesity class (body mass index kg/m² <18.5, 18.5 to 24, 25 to 29, >30). Patients were stratified by age: elderly (age 80 years or older), older (age 65 to 79 years), and younger (age, <65 years). Furthermore, patients were also characterized by coexistent medical comorbidities American Society of Anesthesiologists (ASA) class (1 to 2, ≥3) and surgical details. Medical comorbidities included history of hypertension, diabetes, pulmonary disease, cardiac disease (congestive heart failure of history of myocardial infarction), tobacco use, chronic steroid use, and preoperative nonindependent functional status. Surgical details collected included type of anesthesia (eg, gen-

eral, regional, other/not specified), inpatient versus outpatient setting, surgical indication (eg, osteoarthritis, osteonecrosis, rotator cuff arthropathy, revision arthroplasty, fracture, other), and type of procedure (eg, hemiarthroplasty versus total shoulder arthroplasty).

The primary outcome measures were any major or minor complications or readmissions to the hospital within 30 days of surgery. In addition, secondary outcome measures examined were total operative time, time to discharge to a nursing or rehabilitation facility, and length of hospital stay. Major complications included death, sepsis, septic shock, deep surgical site infection, wound dehiscence, pulmonary embolism, ventilator requirements greater than 48 hours postoperatively, unplanned intubation, acute renal failure, myocardial infarction, stroke, and any acute return to the operating room. Minor complications were identified as superficial surgical site infection, pneumonia, urinary tract infection, deep vein thrombosis, bleeding requiring transfusion, and renal insufficiency.

Summary statistics including mean values, SDs, and ranges were calculated for continuous variables. Categorical variables were reported in terms of frequencies and percentages. For univariate analysis, chi-squared contingency testing was used for categorical variables, whereas analysis of variance was used for continuous variable analysis. *P* value <0.05 was deemed statistically significant. Multivariable logistic regression was then applied to identify independent variables significantly associated with 30-day complications and readmissions. Statistical analysis was performed using the R statistical software package (R Foundation for Statistical Computing).

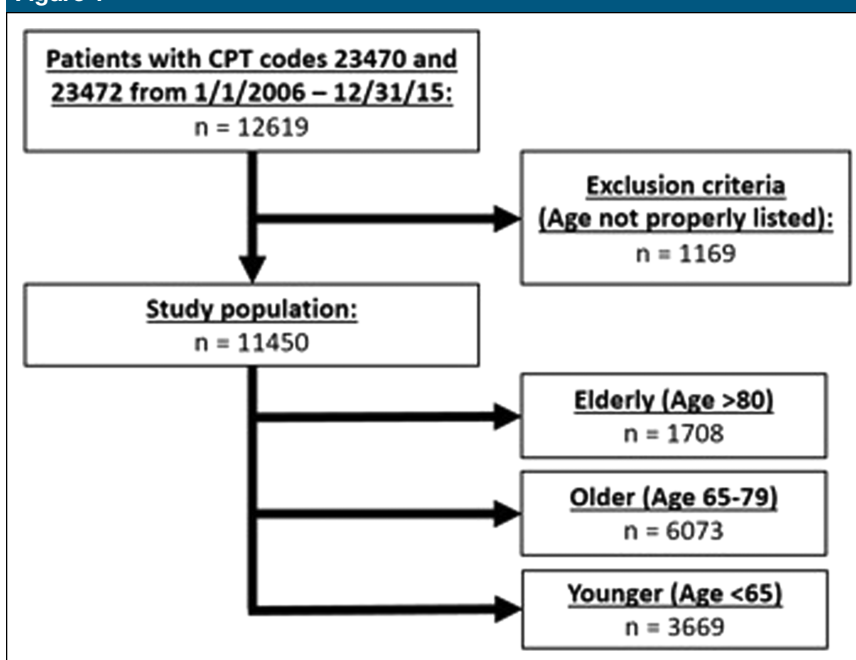
Results

Of the 885,502 cases in the NSQIP database, 12,619 patients were

identified as having undergone total shoulder arthroplasty, reverse total shoulder arthroplasty, and hemiarthroplasty during the 10-year study period. Of these patients, 11,450 had properly documented age for analysis, with the majority being female (4,989 male and 6,461 female) (Figure 1). A total of 1,956 (17.1%) patients underwent shoulder hemiarthroplasty and 9,494 (82.9%) underwent total or reverse shoulder arthroplasty. The most common indication for surgery was glenohumeral osteoarthritis (7,689; 67.1%) while 403 (3.5%) cases were for revision arthroplasty. When stratified by age group, 1,708 (15.0%) were aged 80 years or older, 6,073 (53.0%) were aged between 65 and 79 years, and 3,669 (32.0%) were younger than 65 years. A summary of the remaining preoperative patient characteristics is given in supplemental Table 1 (<http://links.lww.com/JG9/A28>).

Elderly patients (aged ≥ 80 years) were more likely to be female (67.7% versus older women aged 65-79: 59.5% versus younger women aged < 65 46.3%; $P < 0.001$). In addition, they were more commonly treated in the inpatient setting (94.8% versus 94% versus 89%; $P < 0.001$), had lower obesity rates (31.7% versus 52.3% versus 56.6%; $P < 0.001$), were more likely to be undergoing arthroplasty for fracture (13.6% versus 7.5% versus 7.0%; $P < 0.001$), and have an ASA class of three or higher (66.9% versus 56.9% versus 43.6%; $P < 0.001$). Furthermore, as expected, elderly patients were significantly more likely to have a non-independent functional status preoperatively (6.9% versus 4% versus 3.6%; $P < 0.001$). A history of hypertension, diabetes, pulmonary disease, and cardiac disease was significantly associated with older and elderly patients ($P < 0.001$). Smoking was more prevalent in younger patients (22% compared with 7.2% of older and 2.5% of elderly; $P < 0.001$),

Figure 1



Flowchart showing the study design.

and younger patients more commonly underwent shoulder hemiarthroplasty (24.3% compared with 13.1% of older and 15.7% of elderly; $P < 0.001$). Preoperative steroid use and type of anesthesia were not markedly associated with patient age.

The overall complication rate for all patients was relatively low (878; 7.6%). However, the 30-day postoperative complication rate was significantly higher in elderly patients (15.3%), compared with older (8.2%) and younger patients (6.8%; $P < 0.001$; Supplemental Table 2, <http://links.lww.com/JG9/A29>). This extended to both major (4.8% versus 2.4% versus 2.4%; $P < 0.001$) and minor complications (10.7% versus 5.7% versus 4.2%; $P < 0.001$). The most common major complication was pulmonary embolism (0.3%), and the most common minor complication was bleeding requiring transfusion (496; 4.3%). In addition, the 30-day mortality rate was 10, 0.09%. Unplanned readmissions within 30 days occurred in 261 patients (2.3%)

and was twice as likely (5.5%) in the elderly (aged ≥ 80 years) compared with older and younger patient groups (5.5% versus 2.6% versus 2.3%; $P < 0.001$). In addition, discharge to a rehabilitation facility (28.7% versus 11.0% versus 4.0%; $P < 0.001$) and mean length of hospital stays were longer in the elderly compared with older and younger patients, respectively (2.6 days versus 2.1 versus 1.8). Younger patients averaged longer operative time > 120 minutes (41.4% versus 36.6% older versus 33.3% elderly).

Multivariable logistic regression revealed factors that were independently markedly associated with any complication within 30 days of shoulder arthroplasty (Supplemental Table 3, <http://links.lww.com/JG9/A30>). These independent variables included surgery for revision arthroplasty (compared with osteoarthritis as the most common indication; odds ratio [OR], 4.34; $P < 0.001$), surgery for fracture (compared with osteoarthritis as the most

common indication OR, 4.14; $P < 0.001$), history of cardiac disease (OR, 2.33; $P < 0.001$), and elderly (aged ≥ 80 years) patients (OR, 2.01; $P < 0.001$). Other patient-based factors and surgical variables were independently markedly associated with 30-day complications; however, they were not as strongly associated as evidenced by their ORs (Supplemental Table 3, <http://links.lww.com/JG9/A30>).

Discussion

The primary aim of this study was to determine whether elderly patients (aged ≥ 80 years) were at an increased risk of a postoperative complication and 30-day readmission after total shoulder arthroplasty, reverse shoulder arthroplasty, and hemiarthroplasty. We examined a large nationwide database and identified independent predictors of complications within 30 days after surgery. The notable findings of this study are that increasing age is an independent predictor of 30-day complications after total shoulder arthroplasty, reverse shoulder arthroplasty, and hemiarthroplasty. Fifteen percent of elderly patients aged greater than 80 years experienced an early complication within 30 days, and 5.5% had an unplanned readmission within 30 days, which was markedly higher than the younger age groups. This phenomenon may account for the increased length of stay in the elderly patient population (average of 2.6 days) compared with the younger patients (65 to 79: 2.1; < 65 : 1.8 days). In addition, a history of cardiac disease and arthroplasty for fracture or revision surgery are also strong independent predictors of early complications. Other independent predictors of postoperative complications in the elderly included history of pulmonary disease, ASA class ≥ 3 , type of anesthesia, nonindependent functional status, and arthroplasty for osteonecrosis or cuff tear arthropathy.

Several studies have evaluated the influence of patient factors and surgical variables on outcomes, morbidity, and mortality after total shoulder arthroplasty.²³⁻²⁶ In a study design similar to ours, Waterman et al²³ analyzed the 30-day morbidity and mortality rate after elective total shoulder arthroplasty from a 5-year sample of NSQIP data (2006 to 2011). The authors reported a 30-day mortality and complication rate of 0.25% and 3.64%, respectively. In addition, they found that increasing chronologic age was an independent predictor of mortality; however, peripheral vascular disease, and not age, was markedly associated with an increase in any complication.²³ Our results contest these findings and those of Ricchetti et al²⁶ because we found that older age was an independent predictor of 30-day complications. The difference in our findings may be due to the larger sample size in our study. In addition, the current investigation varied in the design methodology from previous studies because we included hemiarthroplasty, total, and reverse shoulder arthroplasty patients for a number of indications, including fracture and revisions, which may account for the differences in the perioperative complication rates.

Cardiac disease was also found to be a strong independent predictor of postoperative complication. Waterman et al²³ reported that cardiac disease was an independent predictor of mortality in their retrospective review of 2004 elective total shoulder arthroplasty patients. Furthermore, Farnig et al²⁵ retrospectively reviewed 15,288 patients who underwent primary total shoulder arthroplasty and hemiarthroplasty over a 10-year period and found that cardiac disease as measured by a high Charlson comorbidity index was independently associated with a complication within 90 days of surgery.

A particular subpopulation of interest in this study are patients who underwent shoulder arthroplasty in the setting of fracture. Shoulder arthroplasty is indicated for irreparable proximal humerus fractures or those injuries with displaced three- or four-part fracture patterns, which are thought to heal poorly with nonsurgical or open reduction and internal fixation. In one of the largest studies examining outcomes after total shoulder and hemiarthroplasty, Farnig et al²⁵ found that fracture patients were at a higher risk of short-term complications within 90 days (OR, 3.2; $P < 0.001$). Our results agree with these findings because a fracture indication was a strong independent predictor of 30-day complication (OR, 4.14; $P < 0.001$). Reasons for higher complications in this patient population may be due to coexistent injuries sustained in the traumatic event, which may not have been adequately coded for within the NSQIP. In addition, shoulder arthroplasty either hemiarthroplasty, total or reverse arthroplasty for proximal humerus fractures are associated with higher complication rates compared with the traditional indication of osteoarthritis, rheumatoid arthritis, or cuff tear arthropathy.

Overall 30-day complications in all patients were relatively rare in the current study (7.6%); however, they were markedly more common in the elderly (15.3%) who were aged greater than 80 years, which included both major complication rate of 4.8% and minor complication rate of 10.7% (Supplemental Table 2, <http://links.lww.com/JG9/A29>). The most common major complications in the elderly patients were return to the operating room (1.6%), pulmonary embolism (0.8%), myocardial infarction (0.7%), and unplanned intubation (0.6%). The most common minor complication rate in this group was blood transfusion (8.4%). The mortality rate was 0.3% in the elderly group compared with zero in the < 65

group and 0.1% in the 65 to 79 group. Our complication rate is slightly higher, but similar to studies by Waterman et al²³ and Fehringer et al,²⁷ which reported 2.8% and 3.64% 30-day major and minor complication rates, respectively. Our inclusion of fracture and revision cases, albeit a small percentage, likely accounts for this higher rate. However, we feel that it is important to include both trauma indications and also revision surgeries because it will help elucidate the true complication rates after shoulder arthroplasty surgery in these three age groups.

The strengths of this study include the large numbers afforded by the American College of Surgeons NSQIP database, which standardizes patient factors and outcomes in an organized and curated manner. This reduces any selection bias because the study population comprises a nationwide and diverse sample. An additional strength of the study was the inclusion of shoulder arthroplasty cases for patients with fracture and those undergoing revision surgery. Although this was a small percentage of the cohort, inclusion of these cases allowed analysis of complications and readmissions in a broad and generalizable arthroplasty population.

Limitations of this study include those inherent to a retrospective review, which is reliant on not only accurate surgeon documentation in the electronic medical record but also precise database entry by NSQIP-qualified reviewers. However, studies have previously demonstrated high interobserver reliability of the NSQIP database for capturing complications and readmissions across all surgical subspecialties.^{22,28-30} Another limitation of the study was our inclusion of patients who underwent total or reverse shoulder arthroplasty or hemiarthroplasty for fracture. Quite often, these patients are multiply injured, which subjects them to a higher complication and readmission

rate, which may have affected our results. However, we decided to include these patients to better understand overall complication rates for shoulder arthroplasty and the degree to which the risk of a complication within 30 days increases in among patients undergoing shoulder arthroplasty for a fracture or revision indication. Similarly, having only a small percentage of revision arthroplasty cases (3.5%) could have also skewed our overall complication rate. However, compared with historical reports, our rate was still relatively low, with an overall complication rate of 7.6%. In addition, we did not separate total shoulder arthroplasty from reverse shoulder arthroplasty because these two procedures are reported as the same procedural codes in the database.

In this analysis of 11,450 shoulder arthroplasty cases, 15.3% of elderly patients, aged 80 years and older, experienced a complication after surgery, and 5.5% had an unplanned readmission within 30 days, both of which were markedly higher compared with patients aged 65 to 79 years and less than 65 years. Although our findings suggest that indication for surgery and comorbidities are higher-quality predictors of complications, elderly patients should be appropriately counseled and preoperatively medically optimized according to their increased perioperative risk profile.

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