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National utilization of reverse total shoulder arthroplasty in the United States

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Background: The substantial increase in the utilization of shoulder arthroplasty in the United States during the past decade is partly attributable to the growing acceptance of reverse shoulder arthroplasty (RSA). This study compared the national utilization of and indications for shoulder hemiarthroplasty, total shoulder arthroplasty (TSA), and RSA.

Methods: The Nationwide Inpatient Sample was used to identify shoulder arthroplasty procedures performed in the United States in 2011. Indicating diagnoses, demographics, and hospital characteristics were identified for each shoulder arthroplasty procedure. Multivariable regression identified factors associated with long hospital stays.

Results: An estimated 66,485 shoulder arthroplasty procedures were identified (33% RSA, 44% TSA, and 23% hemiarthroplasty). Common diagnoses for RSA were rotator cuff tear and arthritis (80%) and proximal humerus fracture (10%). TSA was performed for osteoarthritis in 93% of cases. Hemiarthroplasty was performed for osteoarthritis (45%) and proximal humerus fracture (38%). One quarter of proximal humerus fractures treated with arthroplasty received RSA compared with 69.8% that underwent hemiarthroplasty. Mortality occurred in 0.08% of patients with atraumatic diagnoses but in 0.53% of patients with proximal humerus fractures ($P < .001$). Older patients with comorbidities often had longer hospital stays, as did those with government insurance.

Conclusions: RSAs accounted for one third of all shoulder arthroplasty procedures in the United States in 2011. Whereas the majority of RSAs are performed for rotator cuff tear arthropathy, one quarter of proximal humerus fractures are treated with RSA, suggesting the strong uptake of this relatively new procedure in the United States.

Level of evidence: Epidemiology Study, Database Analysis.

Keywords: Arthroplasty; reverse shoulder arthroplasty; proximal humerus fracture; osteoarthritis; rotator cuff tear; utilization; Nationwide Inpatient Sample

The utilization of shoulder arthroplasty in the United States has seen substantial growth in the past decade. The number of total shoulder arthroplasty (TSA) and hemiarthroplasty procedures increased from approximately 14,000 in the year 2000 to nearly 47,000 in 2008.[11] These statistics, in part, represent an aging population that wishes

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to remain active. Similar increases have also been seen in hip and knee arthroplasty.[12] However, this increase may also represent the widespread popularity of the reverse shoulder arthroplasty (RSA).

RSA has been successful at minimizing pain and maximizing function for many patients with rotator cuff–deficient shoulders. Whereas RSA had been adopted in Europe in the 1980s, it was approved by the Food and Drug Administration (FDA) in the United States in November 2003. Currently, the only FDA-approved indication for RSA is cuff tear arthropathy.[7,8] However, the indications for RSA have rapidly expanded, offering a viable treatment for patients who historically had limited options. These expanding indications now include the acute and delayed treatment of proximal humeral fractures,[3] rheumatoid arthritis, fracture malunion and nonunion, revision arthroplasty, tumor, fixed glenohumeral dislocation,[5] and severe glenoid bone wear.[15]

The extent to which RSA has been used in the United States is unclear. Kim et al[11] reported a substantial increase in TSA between 2003 and 2004, likely representing the adoption of RSA. Until recently, a limitation of administrative databases was that anatomic and reverse TSA used the same *International Classification of Diseases, Ninth Revision* (ICD-9) procedure code (80.80). In October 2010, the ICD-9 procedure codes were updated to give RSA a unique code (80.88). Evaluating the utilization of new procedures is important to identify shifts in practice patterns, to recognize areas for cost-effectiveness improvement, and to identify outcomes and complications that may not be detected in smaller studies.

The purpose of this study was to assess the utilization of RSA in the United States and to describe the associated indications as well as patient and hospital characteristics. This is the first study to report national utilization of RSA, anatomic TSA, and hemiarthroplasty of the shoulder.

Materials and methods

Data source

The 2011 Healthcare Cost and Utilization Project Nationwide Inpatient Sample (NIS) was used, which is a patient-level administrative claims database published annually by the Agency for Healthcare Research and Quality.[9] The data are patient-level inpatient discharges from a random 20% sample of hospitals in the United States. In 2011, there were 1049 hospitals sampled from 46 states, incorporating more than 8 million discharges. Sampling weights are provided to generate national estimates. The NIS includes data such as patient demographics, diagnoses including medical comorbidities, surgical procedures, length of stay, discharge disposition, and hospital charges and estimated costs. In addition, information on the type of hospital is available for each discharge and includes size, location, and teaching status.

Patients were selected by the primary ICD-9 procedure codes. We included patients who received RSA (81.88), TSA (81.80), or shoulder hemiarthroplasty (81.81).

Patient outcomes

We identified the primary indicating diagnosis for each arthroplasty type. All primary ICD-9 diagnosis codes were reviewed. When a primary diagnosis code did not provide a satisfactory explanation for indicating a shoulder arthroplasty, the secondary, tertiary, and subsequent codes were reviewed. Overall, only in 4 of 13,810 arthroplasty procedures (0.03%) could a suitable diagnosis code not be identified, and these patients were excluded. Diagnoses related to osteoarthritis or rotator cuff tendon disease were assumed to signify rotator cuff tear arthropathy if the procedure was an RSA, but these diagnoses were kept separate for TSA and hemiarthroplasty. This was done because there is currently no ICD-9 code specific for rotator cuff tear arthropathy.

Patient characteristics were identified; these included age, sex, race, chronic medical comorbidities, elective vs. nonelective admission, insurance type, and income level based on the quartile of the patient's home zip code (based on U.S. Census estimates). Medical comorbidities were assessed by the Elixhauser definition for diagnosis codes in administrative data.[6] Postoperative outcomes measured included length of stay and mortality. Risk factors for long length of stay were also determined. Income level was not included in multivariable regression because of collinearity with insurance type.

For each patient, we also evaluated the characteristics of the hospital where the procedure was performed. Hospital characteristics were weighted using the hospital sampling weights to estimate the total number of representative hospitals. We tabulated information on hospital size, ownership, teaching status, and annual volume for each shoulder arthroplasty. Hospital costs, excluding surgeon fees, were estimated from reported hospital charges using the cost-to-charge ratio for each hospital, which is provided with the NIS. Costs and charges are reported in 2011 dollars.

Statistical analysis

National estimates of each shoulder arthroplasty type were calculated using patient weights in the NIS. In addition, all statistical comparisons were performed with use of the visit-level survey weights. Continuous variables were compared with a *t* test; categorical variables were evaluated by a χ^2 test. Logistic regression was performed to evaluate risk factors for long length of stay ($\geq$5 days). Poisson regression with robust standard errors, which is appropriate to analyze count data (i.e., number of procedures in this case), was used to evaluate the characteristics associated with hospitals performing RSA, with results reported as incidence rate ratios. Because of the low incidence of mortality in the data set, which is consistent with prior shoulder arthroplasty studies, we were unable to perform a logistic regression for this outcome.

Significance was set with a *P* value $<$.05. All statistical analyses were performed with STATA software (version 12.1; StataCorp, College Station, TX, USA).