Effect of Age on Outcomes of Shoulder Arthroplasty

Oke A Anakwenze, MD; Tameem Yehyawi, MD; Mark T Dillon, MD; Elizabeth Paxton, MA; Ronald Navarro, MD; Anshuman Singh, MD

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ABSTRACT

Context: Outcomes of total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (RTSA) as a function of age are not well known.

Objective: To understand the effects of age on revision rate, mortality, and hospital readmissions.

Design: A retrospective cohort study of prospectively collected data. Using an integrated health care system's shoulder arthroplasty registry, we identified patients who underwent TSA and RTSA between January 2007 and June 2012. Patients were grouped into older (> 75 years) and younger groups (≤ 75 years).

Main Outcome Measures: Differences in outcomes between both age groups.

Results: The TSA cohort had 2007 patients, and 538 (26.8%) were older than age 75 years. Older patients who underwent TSA had higher risks of 1-year mortality (2.0% vs 0.6%; odds ratio = 3.34, 95% confidence interval [CI] = 1.00-11.11, p = 0.049) and readmission within 90 days (7.6% vs 4.4%; odds ratio = 1.75, 95% CI = 1.17-2.63, p = 0.007). The RTSA cohort had 568 patients, and 295 (51.9%) of them were older than age 75 years. Older RTSA patients had a lower risk of revision (3.7% vs 8.1%; hazard ratio = 0.45, 95% CI = 0.24-0.89, p = 0.020).

Conclusion: Patient age is one of many important variables that surgeons should consider when performing shoulder arthroplasty. However, the impact of age in the TSA and RTSA populations is different. In the TSA cohort, older patients have higher risk of readmission and mortality. In the RTSA cohort, older patients have lower risk of revision.

INTRODUCTION

Indications for shoulder arthroplasty are expanding, especially for reverse total shoulder arthroplasty (RTSA) which is now being used to treat conditions beyond rotator cuff arthropathy such as acute fractures, posttraumatic conditions,[1] and irreparable rotator cuff tears.[2] Longer follow-up demonstrates satisfactory midterm outcomes[3] for RTSA and durable long-term results for total shoulder arthroplasty (TSA) recipients.[4] As a result, there has been a rapid increase in the number of shoulder arthroplasty procedures in the US.[5] This increase may be attributable to many factors, including an expanding elderly population. Although a recent study of 26,320 patients who underwent total knee and hip arthroplasty found that patients who were age 80 years and older had a mortality rate that was 3.4 times higher than that observed in patients between age 65 years and age 79 years,[6] the effect of age on shoulder arthroplasty outcomes has yet to be fully elucidated. As such, we sought to determine whether elderly patients may also be at risk of more complications from shoulder arthroplasty than younger patients.

The purpose of this study was to compare the outcomes of TSA and RTSA in a large series of patients on the basis of age. Specifically, we sought to compare the rate of revisions, 1-year mortality, and readmission within 90 days in younger patients (≤ 75 years) vs older patients (> 75 years). An age cutoff of 75 years was chosen a priori to maintain statistical power yet analyze an age group that represents the older arthroplasty group more suitably than previous studies have done. We hypothesized that outcomes would be similar between both groups.

METHODS

A retrospective cohort study of prospectively collected data from a shoulder arthroplasty registry was conducted. The registry was established in 2005 at Kaiser Permanente, a large health care system that has more than 9 million members throughout the US. The data collection procedures, quality control, and participation of the registry have been described.[7] In brief, the shoulder arthroplasty registry collects data (patient, surgical, implant, surgeon, and hospital) for all patients undergoing shoulder arthroplasty using operative forms filled by the treating surgeon, administrative databases, and electronic medical records. The registry monitors postoperative complications such as infections, mortality, revisions, readmissions, and reoperations of the patients. In 2010, the registry captured 100% of procedures performed at our institutions. All elective TSA and RTSA procedures performed between January 2007 and June 2012 in the 2 largest geographic Regions (Southern California and Northern California) that participate in the registry were included in the study.

The outcomes evaluated in this study were revision, 1-year mortality, and readmission within 90 days. Revisions were determined using a comprehensive electronic screening algorithm of electronic medical records. Mortality was obtained from the electronic medical records and membership files in the institution, which tracks member mortality with Social Security Administration files. Readmissions were identified using the inpatient hospitalization encounters also documented by the organization.

Patients were divided into 2 cohorts: TSA and RTSA, then analyzed separately.

Oke A Anakwenze, MD, is an Orthopedist at Olympus Orthopedics Medical Group in San Diego, CA. E-mail: oaa@olympusortho.com. **Tameem Yehyawi, MD,** is an Orthopedic Surgeon at the San Diego Medical Center in CA. E-mail: tameen.yehyawi@kp.org. **Mark T Dillon, MD,** is an Orthopedic Surgeon at the Sacramento Medical Center in CA. E-mail: mark.t.dillon@kp.org. **Elizabeth Paxton, MA,** is the Director of the Surgical Outcomes and Analysis Department at the Sacramento Medical Center in CA. E-mail: liz.w.paxton@kp.org. **Ronald Navarro, MD,** is an Orthopedic Surgeon at the Harbor City Medical Center in CA. E-mail: ronald.navarro@kp.org. **Anshuman Singh, MD,** is an Orthopedic Surgeon at the San Diego Medical Center in CA. E-mail: anshu_singh@hotmail.com.

The main exposure of interest was age, which was grouped into those who were age 75 years or younger (younger patients) and those who were older than age 75 years (older patients). Additionally, the patient characteristics, including sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, and diabetes status, were evaluated as potential risk factors for the studied outcomes. These comorbidity indexes help adjust for confounders other than age, and we included those captured in the shoulder arthroplasty registry as part of the prospective data collection. Randomization would eliminate unmeasured biases in this study, but is simply not feasible retrospectively and with certain metrics, such as age.

The study sample characteristics and the postoperative outcomes were described using frequencies, proportions, median, interquartile range, mean, and standard deviation (SD). Survival analysis was performed on revision using Cox proportional hazard models (Wald test). Cox proportional hazard models assessed the hazard ratio (HR) and 95% confidence interval (CI) for revision while adjusting for other studied risk factors. Follow-up time was defined as the difference between the original operation date and the date of revision, the date of membership termination from the integrated health care system, the date of death, or the end date of the study period, whichever occurred first. Survival analyses censored patients who terminated their membership or died before the end of the study period. A logistic regression model assessed the odds ratio (OR) and 95% CI for mortality and readmission while adjusting for other studied risk factors. All risk estimates are adjusted for surgeon clustering. Analyses were performed using SAS 9.4 software (SAS Institute, Cary, NC), with $\alpha = 0.05$ used as the statistical threshold for significance.

RESULTS

Total Shoulder Arthroplasty

There were 2007 cases included in the TSA cohort, and the patient characteristics are shown in Table 1. The mean follow-up time was 3.1 years (SD = 1.6 years) overall. Of 115 patients (5.7%) who did not complete follow-up, the mean follow-up was 1.8 years (SD = 1.2 years).

Table 2 shows the crude incidence of revision, readmissions, and mortality after elective TSA procedures by patient age group. Overall in the TSA cohort, there were 48 revisions (2.4%), and the cumulative revision rate at 4 years was 3.2% (95% CI = 2.3%-4.3%). Compared with the younger patients, older patients had a higher crude proportion of revision (2.6% vs 2.3%), 1-year mortality (2.0% vs 0.6%), and readmission within 90 days (7.6% vs 4.4%) than did younger patients.

In a model adjusted for age, BMI, ASA score, sex, and diabetes, the risk of TSA revision did not differ between the older and younger patients (HR = 1.24; 95% CI = 0.55-2.79; Table 3). In a similarly adjusted model, older patients were found to have a higher likelihood of 1-year mortality (OR = 3.34; 95% CI = 1.00-11.11, p = 0.049) and readmission within 90 days (OR = 1.75; 95% CI = 1.17-2.63, p = 0.007) compared with patients age 75 years or older.

Reverse Total Shoulder Arthroplasty

There were 568 cases included in the RTSA cohort, and the patient characteristics are shown in Table 1. The mean follow-up time was 2.8 years (SD = 1.5 years). Of 31 patients (5.5%) who did not complete follow-up, the mean follow-up was 1.9 years (SD = 1.2 years).

Table 1. Study sample patient characteristics after elective shoulder arthroplasty (January 2007-June 2012)[a]

Patient characteristic	Older cohort (over 75 years)	Younger cohort (75 years or less)	Total
Total shoulder arthroplasty	538 (26.8)	1469 (73.2)	2007 (100)
Age			
Median (IQR)	79 (77-82)	66 (61-71)	69 (63-76)
Sex			
Women	332 (61.7)	666 (45.3)	998 (49.7)
Men	206 (38.3)	803 (54.7)	1009 (50.3)
BMI (kg/m²)			
Lower than 30	353 (65.6)	707 (48.1)	1060 (52.8)
30 or higher	185 (34.4)	762 (51.9)	947 (47.2)
ASA score			
1 or 2	212 (39.4)	819 (55.8)	1031(51.4)
3 or higher	278 (51.7)	509 (34.7)	787 (39.2)
Unknown	48 (8.9)	14 (9.6)	189 (9.4)
Diabetes			
Present	130 (24.2)	351 (23.9)	48 (24.0)
Reverse total shoulder arthroplasty	295 (51.9)	273 (48.1)	568 (100)
Age			
Median (IQR)	80 (78-83)	70 (65-73)	76 (70-80)
Sex			
Women	205 (69.5)	170 (62.3)	375 (66.0)
Men	89 (30.2)	103 (37.7)	192 (33.8)
BMI (kg/m²)			
Lower than 30	223 (75.6)	154 (56.4)	377 (66.4)
30 or higher	72 (24.4)	119 (43.6)	191 (33.6)
ASA score			
1 or 2	118 (40.0)	114 (41.8)	232 (40.9)
3 or higher	150 (50.9)	120 (44.0)	270 (47.5)
Unknown	27 (9.2)	39 (14.2)	66 (11.6)
Diabetes			
Present	82 (27.8)	82 (30.0)	164 (28.9)

[a] All values are no. (%) unless otherwise specified. Some totals do not equal 100% because of rounding.
ASA = American Society of Anesthesiologists; BMI = body mass index; IQR = interquartile range.

Table 2 reveals the crude incidence of revision, readmissions, and mortality after elective RTSA procedures by patient age group. Overall there were 33 revisions (5.8%), and the cumulative revision rate at 4 years was 8.4% (95% CI = 5.8%-12.1%). Compared with the younger patients, older patients had a lower crude revision rate (3.7% vs 8.1%) and higher crude proportion of 1-year mortality (2.4% vs 1.8%). Both groups had the same rate of readmission within 90 days (9.2%).

In a model adjusted for age, BMI, ASA score, sex, and diabetes, the risk of RTSA revision was significantly lower in older patients compared with younger patients (HR = 0.45; 95% CI = 0.23-0.89, p = 0.020; Table 3). After similar adjustment, there was not enough evidence to show differences in the odds of 1-year mortality or 90-day readmission between the different age groups.

DISCUSSION

In this study, we demonstrated that patients undergoing TSA had higher 1-year mortality and readmission rates when they were older than age 75 years, but with no significant differences in the rate of surgical revision. Conversely, older patients who underwent RTSA had lower rates of revision surgery. To our knowledge, no studies have focused on TSA and RTSA in a specific patient population older than age 75 years.[3,8] Consequently, our data can provide a more focused insight into the risks present for patients in this specific age group who are considering TSA or RTSA.

In a 2014 study, Griffin et al[9] looked specifically at mortality rates and complications during the postoperative hospital stay for patients undergoing hemiarthroplasty or total shoulder arthroplasty and found poorer outcomes in patients older than age 80 years. The mortality rate during inhospital stay was 0.5% for patients older than 80 years vs 0.1% for patients aged 59 to 79 years. The authors also saw longer hospital stays and more frequent complications in this older patient cohort. Our results showed a higher TSA mortality rate looking further out to 1 year of 2.04% in the older cohort vs 0.61% for the younger cohort. Conversely, the mortality rate was similar between older and younger patients in the RTSA population. This difference may reflect the relative health of younger and more active patients who undergo TSA in contrast to patients younger than age 75 years who undergo RTSA. In our study, 55.8% of the younger TSA cohort had ASA scores that were either 1 or 2 compared with 41.8% of the younger RTSA cohort.

Mahoney et al[10] looked at readmission rates after shoulder arthroplasty and noted a 4.5% and 6.6% readmission rate within 90 days after TSA and RTSA, respectively. Schairer et al,[11] using a state inpatient database, looked only at readmission rates after primary shoulder arthroplasty and noted a 90-day readmission rate of 11.2% in the RTSA group and 6% rate in those undergoing TSA. In comparison, our study had a 90-day readmission rate of 5.2% for all patients who underwent shoulder arthroplasty. Schairer et al[11] also found a stepwise increase in readmission with increasing age, which is consistent with our significant finding of a higher 90-day readmission rate for our older patients who underwent TSA. We noted a readmission rate of 4.4% in our younger TSA cohort and 7.6% for our patients over age 75. Our RTSA group was noted to have an overall readmission rate of 9.2%, higher than in the TSA population. This finding is likely caused by higher patient morbidity in our study, compromised local shoulder tissue such as bone quality and quantity that does not get captured in overall health scores, and a higher rate of procedure-specific complications in RTSA vs anatomic TSA. In the RTSA group, we did not note a difference in 90-day readmission rate whether patients were in the older or younger cohort.

Our patients who underwent TSA had a lower overall rate of revision compared with the RTSA group (2.4% vs 5.8%) but did not demonstrate a difference in rates of revision between the older and younger patient cohorts. In their series of patients younger than age 65 years undergoing RTSA, Ek et al[2] reported a complication rate of 37.5% and 25% incidence of prosthesis component exchange, conversion to hemiarthroplasty, or resection. Ricchetti et al[12]

Table 2. Revision, 1-year mortality, and readmission within 90 days after elective shoulder arthroplasty by patient age group

Patient characteristic	Older cohort (over 75 years), no. (%)	Younger cohort (75 years or less), no. (%)	Total, no. (%)
Total shoulder arthroplasty	538 (26.8)	1469 (73.2)	2007 (100.0)
Revision	14 (2.6)	34 (2.3)	48 (2.4)
One-year mortality	11 (2.0)	9 (0.6)	20 (1.0)
Readmission within 90 days	41 (7.6)	64 (4.4)	105 (5.2)
Reverse total shoulder arthroplasty	295 (51.9)	273 (48.1)	568 (100.0)
Revision	11 (3.7)	22 (8.1)	33 (5.8)
One-year mortality	7 (2.4)	5 (1.8)	12 (2.1)
Readmission within 90 days	27 (9.2)	25 (9.2)	52 (9.2)

Table 3. Hazard ratios for risk of revision, and odds ratios for 1-year mortality and readmission within 90 days after elective shoulder arthroplasty

Older than age 75 years vs age 75 years or younger	Ratio	95% confidence interval	p value
Total shoulder arthroplasty			
Revision	HR = 1.24	0.55-2.79	0.607
One-year mortality	OR = 3.34	1.00-11.11	0.049
Readmission within 90 days	OR = 1.75	1.17-2.63	0.007
Reverse total shoulder arthroplasty			
Revision	HR = 0.45	0.23-0.89	0.020
One-year mortality	OR = 0.92	0.32-2.47	0.879
Readmission within 90 days	OR = 0.68	0.41-1.13	0.135

HR = hazard ratio; OR = odds ratio.

studied the differences in complication and mortality rates in patients older than age 80 years who underwent TSA compared with younger patients. They reported no difference in complications between the 2 groups. Conversely, Dillon et al,[8] in a study of 2981 patients who underwent shoulder arthroplasty, found that patients who were younger than age 59 years had a significantly higher rate of revision compared with older patients.

In our study, we found that younger patients who underwent RTSA had an increased rate of revision and failure. The lower revision rate in elderly individuals is likely multifactorial. First, RTSA is designed for low-demand patients. Elderly patients may be more likely to adapt to chronic pain or modest impairment in function. In addition, surgeons may be selecting for a cohort more likely to need revision by performing RTSA in younger patients with very advanced disease states. Surgeons may simply be more hesitant to revise RTSA failures in older patients with increased morbidity. Finally, the higher BMI in the younger cohort may confound this finding, although the impact of BMI on complications after shoulder arthroplasty is still to be determined.[13-17]

In terms of the implications of our findings on health care delivery, a couple of points merit consideration. First is the finding of a greater than 9% readmission rate for patients who underwent RTSA regardless of comorbidities and a readmission rate above 7% in elderly patients who underwent TSA. This likely translates to high utilization of health care resources given the increasing numbers of these procedures. We recommend an analysis of readmission rates, careful patient selection and optimization, and directed support protocols in the perioperative period to decrease the rate of hospital readmission.

Second, our study is not without weaknesses. It is retrospective and subject to the weaknesses and biases of such. However, our registry data are prospectively updated with minimal patient loss, which strengthens our accuracy. This large database study does not have preoperative and postoperative patient outcome scores. However, the clinical improvement after RTSA and TSA has been widely documented[3,18-20] and was not the aim of this study.

CONCLUSION

To our knowledge, this is the first study comparing patient outcomes in patients older than age 75 years undergoing RTSA and TSA. Age is an important factor and appears to affect both groups differently. In the TSA cohort, older patients had a higher mortality and readmission rate; age did not appear to affect the rate of revision surgery. Conversely, older patients in the RTSA cohort had a lower rate of revision compared with the younger patients. Age did not affect mortality or readmission rates in the patients who underwent RTSA. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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