Journal of Orthopaedics 15 (2018) 671–675

Contents lists available at ScienceDirect

Journal of Orthopaedics

journal homepage: www.elsevier.com/locate/jor

Total shoulder arthroplasty in octogenarians: Is there a higher risk of adverse outcomes?

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ARTICLE INFO

Keywords:
Total shoulder arthroplasty
Shoulder arthroplasty
Octogenarian
Complications
Lengths of stay
Perioperative

ABSTRACT

This study used the National Surgical Quality Improvement Program to evaluate octogenarians who underwent total shoulder arthroplasty (TSA). Specifically, we evaluated: (1) patient demographics; (2) perioperative factors; and (3) 30-day postoperative complications. Compared to controls, the octogenarians had more females, white patients, lower BMIs, fewer smokers, less functionally independent, higher ASA scores, shorter operative times, and longer LOS. Octogenarians had greater odds for developing any (OR = 2.05; 95%CI, 1.70–2.46), any major (OR = 2.28; 95%CI, 1.66–3.13), and any minor (OR = 1.99; 95%CI, 1.63–2.45) complications. Perioperative risk management strategies for elective TSA in the elderly may help mitigate the increased perioperative risks associated with age.

1. Introduction

From 2000 to 2010, the number of Americans 80 years and older grew from 13.4 million to 16.7 million, representing a 25% increase.[1] As Americans live longer, they continue to access care as evidenced by an estimated 14% of the procedures performed in ambulatory surgical centers are done on those over 75.[2] Age alone is known to be a risk factor for perioperative morbidity and mortality, with one study reporting the 30-day mortality to be 51% in patients over 80 years across multiple surgical procedure types.[3] Increases in operative length in particular have also been associated with increased mortality in those over 80 years.[3] Special considerations already exist for the practice of surgical risk management in such patients, including careful preoperative cardiovascular risk assessment, selection of short-acting and regional anesthetic agents, and attempting to minimize operative length.[3–6] However, for specialized procedures such as total shoulder arthroplasty (TSA), these general recommendations might need to be further adjusted.

The number of TSA procedures performed in the United States has increased alongside the aging population in recent years, with one study finding two-thirds of TSA patients to be over 65 years of age.[7] Approximately 49 per 100,000 of those above 80 years of age undergo TSA, second only to patients aged 65–79 years.[8] Mortality and readmission rates have been suggested to be higher for patients over 75 years who undergo TSA compared to younger patients, with similar rates of revision surgery.[9] Additional data on disposition and lengths of stay (LOS) exist for these patients, but more specific data describing complications and perioperative patient characteristics are lacking.[8]

Therefore, the purpose of this study was to use a large prospectively collected national database to evaluate patients aged 80 years and older who underwent TSA to compare these patients to a cohort who were younger than 80 years. Specifically, we evaluated: (1) patient demographics; (2) perioperative factors such as anesthesia type, American Society of Anesthesiologists (ASA) score, operative time, lengths of stay (LOS); and (3) 30-day postoperative complications.

2. Materials and methods

2.1. Database

The present study used the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database, which is a validated, prospectively collected, risk-adjusted database that collects data on patients who undergo surgery from approximately 700 hospitals in the United States.[10–13] Surgical clinical reviewers, trained by the ACS, record perioperative data at each hospital, including demographics, laboratory values, comorbidities, diagnosis as defined by International Classification of Disease 9th and/or 10th Revisions (ICD-9,

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https://doi.org/10.1016/j.jor.2018.05.035
Received 24 February 2018; Accepted 6 May 2018
Available online 08 May 2018

ICD-10) codes, surgical procedure defined by Current Procedural Terminology (CPT) codes, and data related to discharge disposition, reoperations, readmissions, and mortality through 30 days postoperatively.

2.2. Study population

The NSQIP database was used to identify all patients who underwent TSA as defined by the CPT code 23472, from January 1, 2008 to December 31, 2015. A total of 10,353 patients were identified and were then stratified into two cohorts based on age, which resulted in 8802 patients less than 80 years and 1551 octogenarians who underwent TSA and were included in the study.

2.3. Patient demographics

Patient demographics included age, sex, race (white, black, other), body mass index (BMI), calculated from reported height and weight) categories, including less than 24.9 kg/m^2, 25 to 29.9 kg/m^2, 30 to 34.9 kg/m^2, 35 to 39.9 kg/m^2, and > 40 kg/m^2, smoking status, and functional status. In addition, using the available comorbidity data, a modified Charlson comorbidity score was calculated.[14] The modified Charlson score has been reported to be similar in efficacy when compared with the original Charlson score.[15,16] The following comorbidities were included and were assigned the following point values: chronic obstructive pulmonary disease (1 point), congestive heart failure (1 point), renal failure/end-stage renal disease (2 points), on a ventilator (2 points), ascites (3 points), and cancer (6 points); the scores were categorized as 0, 1, or ≥2.

2.4. Perioperative factors

The perioperative data collected included anesthesia type (general, regional or local, and other), American Society of Anesthesiologists (ASA) scores (categorized as greater than or equal to 3 or less than 3). Additionally, the operative times (in minutes) and the hospital LOS (in days) were extracted from the database.

2.5. Postoperative complications

The 30-day postoperative complications were stratified by any, major, and minor complications, as described by previous studies.[17,18] The major complications included stroke, cardiac arrest, myocardial infarction, pulmonary embolism, unplanned re-intubation, on ventilator for > 48 h, acute renal failure, sepsis, and septic shock. The minor complications included superficial incisional surgical site infection, deep incisional surgical site infection, organ space infection, wound dehiscence, pneumonia, urinary tract infection, deep vein thrombosis, renal insufficiency, and transfusion.

2.6. Data analysis

All statistical analyses were performed with SPSS version 23 (IBM Corporation, Armonk, New York). All tests were two-tailed and a p-value of less than 0.05 was used to determine statistical significance. Descriptive statistics were performed for all study variables. Patient demographics including gender, race, BMI, Charlson scores, smoking history, and functional status, as well as perioperative data, were compared with chi-square and Fisher's exact tests for categorical variables, and student's *t*-test was used for continuous variables. Then, logistic regression was used to calculate the odds ratios (OR) and 95% confidence intervals (95% CI) of any, major, and minor complications that occurred within 30 days postoperatively, while controlling for sex, race, BMI category, and Charlson/Deyo scores.

Table 1
Demographics of total shoulder arthroplasty patients.

Parameters	< 80 years	≥80 years	P-value
Number	8802	1551	n/a
Gender, % (n)			< 0.0001
Female	55 (4800)	66 (1028)	
Male	45 (3998)	34 (521)	
Race, % (n)			< 0.0001
White	85 (7477)	89 (1383)	
Black	5 (406)	2 (32)	
Other/Unknown	10 (919)	9 (136)	
BMI categories (kg/m^2), % (n)			< 0.0001
< 24.9 kg/m^2	15.7 (1381)	27.4 (423)	
25–29.9 kg/m^2	31.3 (2751)	40.9 (632)	
30–34.9 kg/m^2	26.9 (2366)	22.3 (344)	
35–39.9 kg/m^2	14.8 (1299)	6.4 (99)	
> 40 kg/m^2	11.2 (988)	3.1 (48)	
Charlson/Deyo score, % (n)			0.084
0	77.6 (6829)	78.5 (1218)	
1	20.2 (17,770)	20.1 (312)	
≥2	2.2 (196)	1.4 (21)	
Smoker, % (n)	11.8 (1037)	2.4 (37)	< 0.0001
Functional status, % (n)			< 0.0001
Independent	96.6 (8505)	93.7 (1454)	
Partially dependent	2.5 (224)	5.1 (79)	
Totally dependent	0.1 (8)	0.5 (7)	
Unknown	0.7 (65)	0.7 (11)	

BMI = body mass index.

3. Results

3.1. Demographics

The mean age of the octogenarian cohort was 83 years (range, 80–89 years), and for the less than 80 years cohort, the mean age was 67 years (range, 19–79 years). Compared to the less than 80 years cohort, the octogenarians had significantly more females (66 vs. 55%, $p < 0.0001$), were more likely to be white (89 vs. 85%, $p < 0.0001$), had lower BMIs (28.1 vs. 31.4 kg/m^2, $p < 0.0001$), were less likely to smoke (2.4 vs. 11.8%, $p < 0.0001$), and were less likely to be functionally independent (93.7 vs. 96.6%, $p < 0.0001$). Modified Charlson score distributions did not vary significantly between the two cohorts ($p = 0.084$) (Table 1).

3.2. Perioperative factors

Compared to the less than 80 years cohort, octogenarians had higher ASA scores ($p < 0.0001$), shorter operative times (108 vs. 115 min, $p < 0.0001$), and longer LOS (3 vs. 2 days, $p < 0.0001$) (Table 2).

3.3. Postoperative complications

Compared to less than 80 years cohort, octogenarians had a 105% higher risk for any complication (OR = 2.05; 95% CI, 1.70–2.46; $p < 0.0001$), 128% higher risk for any major complication (OR = 2.28; 95% CI, 1.66–3.13; $p < 0.0001$), and a 99% higher risk for any minor complication (OR = 1.99; 95% CI, 1.63–2.45; $p < 0.0001$) (Table 3). For the specific major complications, compared to the less than 80 years cohort, the octogenarians were more likely to be re-intubated (OR = 9.34; 95% CI, 3.56–24.79; $p < 0.0001$), on a ventilator for > 48 h (OR = 11.27; 95% CI, 2.83–44.82; $p = 0.001$), develop a pulmonary embolism (OR = 3.91; 95% CI, 1.87–8.19; $p < 0.0001$), acute renal failure (OR = 15.86; 95% CI, 2.29–109.88; $p = 0.005$), a stroke (OR = 3.95; 95% CI, 1.18–13.25; $p = 0.026$); a myocardial infarction (OR = 4.91; 95% CI, 1.93–12.52; $p = 0.001$), and septic shock (OR = 12.36; 95% CI, 2.29–66.75; $p = 0.003$) (Table 4). Also, for the specific minor complications, compared to the

Table 2
Perioperative factors.

Parameters	< 80 years	≥80 years	P-value
Anesthesia, % (n)			0.066
General	96.1 (8458)	95.2 (1477)	
Regional or Local	3.2 (282)	4.4 (68)	
Other	0.7 (62)	0.4 (6)	
ASA score, % (n)			< 0.0001
< 3	50 (4402)	35 (541)	
≥3	50 (4388)	65 (1010)	
Operative time, minutes, mean (± SD)	115.6 ± 48.4	108.3 ± 41.8	< 0.0001
LOS, days, mean (± SD)	2 ± 2.8	3 ± 3.3	< 0.0001

ASA = American Society of Anesthesiologists; LOS = lengths of stay.

Table 3
Regression analysis of postoperative complications in octogenarians compared to patients aged less than 80 years.

Parameters	Odds ratio (95% CI)	P-value
Any complication	2.05 (1.70 to 2.46)	< 0.0001
Major complications	2.28 (1.66 to 3.13)	< 0.0001
Minor complications	1.99 (1.63 to 2.45)	< 0.0001

less than 80 years cohort, the octogenarians were more likely to develop pneumonia (OR = 2.03; 95% CI, 1.08–3.83; p = 0.028), renal insufficiency (OR = 6.03; 95% CI, 1.59 to 22.85; p = 0.008), urinary tract infections (OR = 2.72; 95% CI, 1.67–4.45; p < 0.0001), and receive a blood transfusion (OR = 1.97; 95% CI, 1.56–2.49; p < 0.0001).

4. Discussion

In the United States, the number of TSAs performed annually in older patients has increased, with most patients being older than 65 years.[7] Despite the success of the surgery, elderly patients may be at a greater risk of adverse events after surgery, such as hospital readmission, longer LOS, and mortality. However, the literature on the adverse outcomes in patients aged 80 years and older is limited. The present study found that compared to patients younger than 80 years, octogenarians who underwent TSA were more commonly white women who had lower BMIs and were more dependent on others for activities of daily living, and tended to have longer LOS and increased complication rates after surgery.

There were some limitations to the present study. Since this database uses CPT codes for identifying surgical procedures, we were unable to differentiate between TSA and reverse TSA; however, other large database studies have shown that when evaluating shoulder arthroplasty, 42%–44% were TSAs, 32% to 37% were reverse TSAs, and 21% to 23% were hemiarthroplasties,[19,20] and the outcomes of TSA and reverse TSA in patients older than 80 years have been shown to be similar.[21] A previous report found that elderly patients were more likely to be admitted to the ICU during surgical care; information about patient location within the hospital (e.g. surgical intensive care unit or a step-down unit) may thus prove useful to remove level of care as a potential confound for age with respect to complication rates.[22] Finally, collection of data for reverse shoulder arthroplasty (RSA) procedures is encouraged in future studies, as RSA incidence is increasing and outcome data are scarce.[19] Despite these limitations, this study provides an important insight into the postoperative outcomes of octogenarians who undergo TSA.

The results to the present study are in accordance with other studies that have reported on TSA patients. For example, 66% of patients in our octogenarian cohort were female, consistent with previous reports of a higher percentage of female TSA patients in this age range [8]. Also, female gender has previously been shown to be a risk for intraoperative complications during shoulder arthroplasty in addition to an increased age.[23] Additionally, significantly more of the octogenarians were white and had lower average BMI as compared to the under-80 cohort, though the BMI in the octogenarian cohort was still in the overweight range. Combined with the fact that the under-80 cohort was more likely to be

Table 4
Frequency and odds of major and minor complications.

Parameters	< 80 years	≥80 years	Odds ratio (95% CI)	P-value
Major				
Stroke	0.10%	0.30%	3.95 (1.18 to 13.25)	0.026
Cardiac arrest	0.00%	0.00%	n/a	n/a
MI	0.10%	0.60%	4.91 (1.93 to 12.52)	0.001
Pulmonary embolism	0.30%	0.80%	3.91 (1.87 to 8.19)	< 0.0001
Re-intubation	0.10%	0.60%	9.34 (3.56 to 24.79)	< 0.0001
On ventilator > 48 hours	0.04%	0.40%	11.27 (2.83 to 44.82)	0.001
Acute renal failure	0.02%	0.20%	15.86 (2.29 to 109.88)	0.005
Sepsis	0.20%	0.30%	1.75 (0.61 to 5.02)	0.294
Septic Shock	0.02%	0.30%	12.36 (2.29 to 66.75)	0.003
Minor				
Superficial SSI	0.20%	0.00%	n/a	n/a
Deep SSI	0.10%	0.10%	0.54 (0.07 to 4.27)	0.557
Organ space infection	0.10%	0.10%	0.47 (0.06 to 3.73)	0.478
Wound dehiscence	0.10%	0.10%	0.64 (0.08 to 5.23)	0.678
Pneumonia	0.40%	0.90%	2.03 (1.08 to 3.83)	0.028
Urinary tract infection	0.60%	1.70%	2.72 (1.67 to 4.45)	< 0.0001
Deep vein thrombosis	0.30%	0.30%	1.08 (0.41 to 2.87)	0.880
Renal insufficiency	0.10%	0.30%	6.03 (1.59 to 22.85)	0.008
Transfusion	3.30%	7.20%	1.97 (1.56 to 2.49)	< 0.0001

MI = myocardial infarction; SSI = surgical site infection.

functionally independent, these data suggest that there may be increased vulnerability to insults among the octogenarian cohort beyond increasing age.

Increased age, along with decreased functional status, has also been previously been associated with increased postoperative LOS.[24] The significantly increased LOS seen among 80-and-above patients in the present study was a risk factor in itself for perioperative morbidity and mortality, including acquisition of hospital-acquired infections in a surgical ICU setting.[25,26] The decreased functional status of the 80-and-above cohort compared to the under-80 cohort may have also predisposed them to preventable complications like acquisition of infection or development of pressure sores.[27] Beyond operative time, LOS and functional status may thus provide points of intervention for further risk management in elderly TSA patients. However, such interventions depend on the indication for TSA, such as the potential use of preoperative physical therapy aimed at optimizing mobility and functional independence before surgery is limited in the setting of emergent TSA for fall-related fractures. Similarly, though interdisciplinary postoperative planning between rehabilitation specialists, hospitalists, orthopaedic surgeons, and others may help reduce LOS, application of this practice may be complicated in patients with multiple injuries requiring multiple procedures.[28]

Octogenarians experienced significantly shorter TSA operative durations as compared to those 80 and under. This suggests awareness among the surgical and anesthetic teams of operative duration as a risk factor for morbidity and mortality among these patients, and indicates that risk management strategies may already be in place. However, regression analysis revealed that the octogenarian cohort exhibited significantly more complications of any type despite this decrease in operative times relative to the younger cohort of patients. Given that the modified Charlson scores were not significantly different between groups, it is likely that the increase in complication rates was truly correlated with increasing age. This effect of age on complication rates is consistent with reports from previous studies.[3,23,29] The results of the present study are in accordance with those of Saltzman et al.[30] who reported on 111 patients who had a mean age of 74 years who underwent primary TSA and found that 25% of patients developed any complication, with 9% major and 20% minor complications, including pulmonary embolus, renal insufficiency, asystole, and transfusion. However, our study differs from Ricchetti et al.[31] who reported on the 90-day outcomes of 40 patients who were 80 years or older and 46 patients who were less than age 70 years who underwent TSA. They found that there were no significant differences between the older and younger groups in terms of major (7 vs. 2%, $p = 0.35$) or minor (23vs. 17%, $p = 0.18$) complication rates. However, they found that the older group had a higher rate of blood transfusions compared to the younger patients.

5. Conclusion

Our results confirmed that octogenarians who undergo TSA are at an increased risk of complications. Our observation of significantly shorter operative duration in these patients suggests risk management strategies are being applied but have not managed to fully mitigate the increase in perioperative risks associated with age. Lengths of stay and preoperative care, including optimization of functional independence for elective TSA procedures, may provide points of intervention for further risk management schema.

Conflicts of interest

Jared M. Newman, Sarah G. Stroud, Andrew Yang, Nipun Sodhi, Anant Dixit, James P. Doran, Andrew J. Hayden, Danielle J. Casagrande, Michael A. Mont: None.

Dr. Mont reports grants and other from Stryker, grants and other from DJO Global, grants and other from Sage Products, grants and other from TissueGene, grants and other from OnGoing Care Solutions, grants and other from Microport, grants and other from Orthosponsor, grant and other from National Institute of Health, grants and other from Jhonson and Jhonson, grants and other from Pacira Pharamaceutical, grants and other from Cymedica, grants and other from Peerwell, grants and other from Performance Dynamics Inc, grants from MallinckrodtPharmaceutical, grants from Abbott, grants from Mez, grants from Medical Compression Systems, outside the submitted work.

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