Research Article

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Perioperative Factors Affecting the Length of Hospitalization After Shoulder Arthroplasty

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Abstract

Objective: To determine factors related to length of hospitalization after shoulder arthroplasty.

Methods: A retrospective review identified patients who underwent shoulder arthroplasty between 2009 and 2012 at our institution. Factors were evaluated for their association with hospitalization length in a univariate model. Diagnoses were categorized into four groups: (1) osteoarthritis, cuff tear arthropathy, massive rotator cuff tear, or osteonecrosis; (2) acute fracture or fracture sequelae; (3) inflammatory arthropathy; and (4) failed shoulder arthroplasty. Significant factors were then evaluated using a multivariate model.

Results: Four hundred twenty-five shoulder arthroplasties were identified (average age, 66.9 years). Arthroplasty type significantly affected hospitalization length. Significant factors for increased hospitalization using multivariate analysis were diabetes mellitus, American Society of Anesthesiologists score of 3 or 4, acute fracture or fracture sequelae diagnosis, inflammatory arthropathy, and a blood transfusion.

Discussion: Independent factors using multivariate analysis are diabetes, an American Society of Anesthesiologists score ≥3, fracture or fracture sequelae, inflammatory arthritis, and a perioperative blood transfusion.

Level of Evidence: Level III therapeutic study

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The costs associated with an increased length of hospitalization burden the healthcare system's shrinking budget.[1,2] An understanding of the factors associated with an increased length of stay can improve patient care and cost effectiveness and possibly guide future reimbursement. Among orthopedic surgeries, shoulder arthroplasty is becoming increasingly more common,[3] with the rate of shoulder arthroplasty in patients >55 years old increasing to 12% per year and projected to increase by 755% in 2030.[4] Similarly, the need for revision shoulder arthroplasty is growing.[5] Knowledge about the factors that affect the length of hospitalization after shoulder arthroplasty is important to make clinical practice changes, improve healthcare delivery efficiency, and start integration back to home as soon as possible.

Several reports have looked at a few preoperative factors and their effect on outcomes, including the length of hospitalization after shoulder arthroplasty,[6–11] but the majority do not use multivariate analysis. Few articles have performed a multivariate analysis of factors affecting the length of stay, and all of them focus on large administrative databases[12–15] with inherent limitations and an inability to evaluate specific preoperative variables, such as laboratory values, anticoagulation use, and blood transfusions. Large databases are able to examine large populations but have significant limitations, including inadequate patient sampling, missing variables, incomplete or inaccurate data entry, and lack of orthopaedic-specific variables.[16]

This study evaluates specific perioperative factors affecting the length of hospitalization after shoulder arthroplasty at a tertiary referral center, including factors that large database studies cannot evaluate. We hypothesized that this study will likely identify new factors associated with the length of hospitalization, including lower preoperative hemoglobin, use of preoperative anticoagulation, and the need for a perioperative blood transfusion.

Methods

Study Design and Patients

A retrospective review identified patients in our shoulder research database who underwent shoulder arthroplasty from 2009 to 2012 at a tertiary-care referral center. Demographic, operative, and clinical information were abstracted for analysis. The University of Florida Institutional Review Board approved this study. The inclusion criterion was any shoulder arthroplasty performed between November 1, 2009, and December 1, 2012, by the senior author (T.W.W.). We reviewed 470 patients for inclusion criteria who had shoulder arthroplasties during the study period.

Patient Characteristics

Patient demographic data included the following: age at surgery, sex, ethnicity, body mass index (BMI), comorbidities (hypertension, diabetes, and heart disease), American Society of Anesthesiologists (ASA) score, preoperative anticoagulation, diagnosis, and preoperative hematocrit level.

Preoperative diagnoses were placed into one of the four categories: (1) osteoarthritis, cuff tear arthropathy, massive rotator cuff tear, or osteonecrosis; (2) acute fracture or fracture sequelae; (3) inflammatory arthropathy; and (4) failed shoulder arthroplasty. While several diagnoses were combined, these categories were not divided further because of a small number of patients in some categories and to allow for multivariate analysis. Group 1 was used as the reference group for the statistical analysis. Preoperative hematocrit was defined as a hematocrit level obtained within 6 weeks of the procedure. The ASA score was defined as the ASA score recorded by the anesthesiologist during the patient's preoperative appointment. Because of the number of patients in each group, the ASA scores were grouped as a score of 1 or 2 for first group and 3 or 4 for the second group for statistical analysis. Use of preoperative anticoagulation was analyzed using two methods: (1) use of clopidogrel, enoxaparin, or warfarin anticoagulants and (2) clopidogrel, enoxaparin, warfarin, or aspirin (81 or 325 mg) anticoagulants. Patients were advised to stop all anticoagulation medication 7 days before surgery if deemed safe by the physician managing their anticoagulation.

Shoulder Arthroplasty Procedures

Shoulder arthroplasty procedures included the following: resurfacing shoulder arthroplasty, shoulder hemiarthroplasty (HA), reverse total shoulder arthroplasty (RTSA), total shoulder arthroplasty (TSA), antibiotic spacer placement, or revision shoulder arthroplasty. For all surgeries, a deltopectoral approach was used. The majority of patients had press-fit humeral component fixation except for the patients with acute fracture, for whom cementation was generally used. The deltopectoral interval was closed with interrupted absorbable suture. Skin was closed with a subcuticular closure and Dermabond (Ethicon US). Drains were not used. Mechanical

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compression devises were routinely used in the postoperative period only during the hospital stay.

Study Outcome Measures

The length of hospitalization was the primary variable of interest in this study. The length of hospitalization was defined as the number of nights spent in the hospital. Secondary data points included the following: estimated blood loss, postoperative hematocrit level, change in hematocrit level, and the need for a blood transfusion. Postoperative hematocrit level was defined as the lowest level obtained intraoperatively or during the postoperative hospital stay. Serum laboratory values were routinely drawn on the day after surgery and on an as-needed basis thereafter. Change in hematocrit level was calculated only if both laboratory values were available. Blood transfusion was defined as an intraoperative or postoperative allogeneic red blood cell transfusion during the patient's hospital stay (autogenous blood transfusions were not used). Anticoagulation medications taken before surgery were restarted on the first postoperative day.

Statistical Analysis

Data were reviewed for errors, outliers, and approximation to normative distribution. Groups were compared using chi-square tests for categorical variables and *t*-tests for continuous variables. Bivariate analysis was conducted using chi-square tests for categorical variables and *t*-tests for continuous variables. Initial univariate analyses were run on the variable. A multiple logistic regression was used to assess prediction of the length of hospitalization for those variables found to be significant in the univariate analysis. SAS version 9.2 (SAS Institute) was used for all analyses. The level of significance was set at 0.05 for all statistical tests. All comparisons were calculated as two-sided tests.

Results

A total of 470 shoulder arthroplasties were performed at our center during the study. Thirty-two were excluded because they were performed by two surgeons other than the senior surgeon. The senior surgeon performed the remaining 438 shoulder arthroplasties, with 13 having 2 surgeries during the study period in which only the first surgery was included for this study. This left 425 shoulder arthroplasties to be included in this analysis. Patient characteristics are shown in Table 1. There was a similar distribution of sex, and most patients were Caucasian and classified as ASA 3. The average BMI indicated that the average patient was overweight. The average age at surgery was 66.9 years.

For the preoperative diagnosis, group 1 included 69% of the population, comprising the following: 158 patients with degenerative arthritis, 119 with cuff tear arthropathy, 11 with osteonecrosis, and 6 with a massive rotator cuff tear with mild glenohumeral chondromalacia. Group 2 included 26 patients with fracture sequelae and 15 patients with acute fractures. Patients with fracture sequelae had a similar length of stay compared with patients with acute fracture (2.3 vs. 2.4 nights, $P = 0.77$) and were included together for the remainder of this study. Group 3 included 14 patients with inflammatory arthropathy. Group 4 consisted of 76 patients with failed arthroplasty, including 18 with antibiotic spacer placement.

The type of procedure performed significantly affected the length of hospitalization. Patients who underwent TSA had the shortest hospital stays, followed by those who underwent HA/resurfacing, RTSA, revision arthroplasty, and antibiotic spacer placement (Table 2). However, surgical procedure was analyzed using only univariate analysis because of the association between procedure and preoperative diagnosis (ie, revision arthroplasty and antibiotic spacer placement groups comprised the failed arthroplasty group). Insignificant factors in univariate analysis were age, BMI, heart disease, kidney or liver disease, prior shoulder surgery, and preoperative hematocrit. Significant factors associated with an increased length of hospitalization in univariate analysis, but not in multivariate analysis, were sex, ethnicity, hypertension, significant preoperative anticoagulation, estimated blood loss, and postoperative hematocrit level (Tables 1 and 2). Factors not included in the multivariate analysis because of their similarities or relationships with other variables were surgical procedure, any prior anticoagulation, and change in hematocrit level.

Significant factors leading to an increased length of hospitalization using multivariate analysis were diabetes mellitus (2.3 vs. 1.7 nights), an ASA score of 3 or 4 (1.9 vs. 1.4 nights), a preoperative diagnosis of acute fracture or fracture sequelae (2.3 vs. 1.5 nights), a preoperative diagnosis of inflammatory arthropathy (2.1 vs. 1.5 nights), and the need for a blood transfusion (3.5 vs. 1.5 nights). Complete data are listed in Tables 1 and 2. A trend toward an increased length of stay was also seen with a preoperative diagnosis of failed shoulder arthroplasty (2.2 vs. 1.5 nights; $P = 0.06$).

Discussion

We evaluated specific perioperative factors, gathered from a prospective research database, associated with an increased length of hospitalization after shoulder arthroplasty using a multivariate model, including some variables not previously assessed. Several recent studies have reported factors associated with the length of hospitalization after shoulder arthroplasty[12–15,17]; however, their use of public databases prevents evaluation

Table 1

Patient Demographics and Health History Evaluated Using Univariate and Multivariate Analyses

Variables	Descriptors Mean or Number (Percentage of Total)	Statistical Analysis		
		Length of Stay Spearman Coefficient or Mean With SD	Bivariate *P* Value	Multivariate *P* Value
Age (yr)	66.9 ± 10.3	0.06	0.2385	—
Sex				
Male	218 (48.7)	1.6 ± 1.7	<0.0001	0.8425
Female	207 (51.3)	1.9 ± 1.3		
Ethnicity				
Caucasian	400 (94.1)	1.7 ± 1.5		Control
African American	18 (4.2)	2.4 ± 1.9	0.0407	0.1615
Hispanic	7 (1.7)	1.3 ± 0.5		0.6921
Body mass index	29.4 ± 6.0	−0.01	0.7994	—
Hypertension				
No	221 (52)	1.6 ± 1.2	0.0295	0.7517
Yes	204 (48)	1.9 ± 1.8		
Diabetes				
No	353 (83.1)	1.7 ± 1.3	0.0002	0.0145
Yes	72 (16.9)	2.3 ± 2.4		
Heart disease				
No	357 (84)	1.7 ± 1.6	0.1456	—
Yes	68 (16)	1.9 ± 1.4		
Chronic kidney or liver disease				
No	407 (95.8)	1.7 ± 1.5	0.3574	—
Yes	18 (4.2)	2.4 ± 2.3		

of some specific factors (such as laboratory values and preoperative anticoagulation) that cannot be examined because of inherent limitations. These databases are prone to data entry errors and missing data.[18,19] Several recent studies have also questioned the reliability of *ICD-9* codes in administrative databases[20,21] because these databases are intended for billing and not for research purposes, which can add significant bias. In addition, one major limitation of registry databases (such as the American College of Surgeons National Surgical Quality Improvement Program) is that, although they are intended for research, they represent only a sample of patients in the United States because centers must agree to participate.[16]

The length of hospitalization reported in this study is shorter than those in all current studies in the literature,[6–13,17,22] reporting 1.4 days for TSA, 1.6 days for HA or resurfacing, and 1.8 days for RSTA. One public database study shows that the length of stay after shoulder arthroplasty decreased between 1998 and 2012,[14] which may account for the shorter length of stay seen in this study, given the recent period assessed. Several studies have shown that higher-volume surgeons reported a shorter length of hospitalization after shoulder arthroplasty,[7,11,17] which may explain the shorter length of hospitalization found here.

In our study, TSA required the shortest length of hospitalization, followed by, in increasing order, resurfacing/HA, RTSA, revision shoulder arthroplasty, and antibiotic spacer placement. Dunn et al[13] reported that the average length of hospitalization after combined TSA and RTSA was 2.2 days, which is longer than in our study. Extended length of stay (>75th percentile) was not different when comparing TSA to RTSA patients in one study.[15] Patients with HA had a significantly longer length of stay in multivariate analysis compared with those with TSA in a database study of 1,868 patients,[17] although this may be because of higher numbers of HA for fracture. In our patient population, patients with TSA were younger and healthier, which may partly explain the shorter length of hospitalization seen in this study.

Table 2

Perioperative Factors Assessed With Univariate and Multivariate Analyses

Variables	Descriptors Mean or Number (Percentage of Total)	Statistical Analysis: Length of Stay Spearman Coefficient or Mean With SD	Bivariate *P* Value	Multivariate *P* Value
ASA score				
1	3 (0.7)	1.0 ± 0.0		
2	145 (34.2)	1.4 ± 0.8	0.0054	0.0304 (1/2 vs. 3/4)
3	271 (63.9)	1.9 ± 1.8		
4	5 (1.2)	2.4 ± 2.6		
CEWA anticoagulation				
No	254 (59.5)	1.7 ± 1.6	0.0481	NI
Yes	172 (40.5)	1.8 ± 1.4		
CEW anticoagulation				
No	385 (90.6)	1.7 ± 1.6	0.0353	0.5485
Yes	40 (9.4)	1.9 ± 1.2		
Prior shoulder surgery				
No	260 (61.2)	1.7 ± 1.3	0.0761	—
Yes	165 (38.8)	1.9 ± 1.9		
Diagnosis				
DJD, RCA, MRCT, and osteonecrosis (nontraumatic)	294 (69.2)	1.5 ± 1.2		Control
Fx or Fx sequelae	41 (9.6)	2.3 ± 1.3	<0.0001	0.0313
Inflammatory arthritis	14 (3.3)	2.1 ± 2.0		0.0108
Failed arthroplasty	76 (17.9)	2.2 ± 2.4		0.0624
Surgical procedure				
Hemiarthroplasty or resurfacing	21 (4.9)	1.6 ± 1.8		
TSA	136 (32)	1.4 ± 1.0		
Reverse TSA	194 (45.7)	1.8 ± 1.4	<0.0001	NI
Revision arthroplasty	56 (13.2)	2.1 ± 2.6		
Antibiotic spacer	18 (4.2)	2.9 ± 1.5		
Preoperative hematocrit	40.5 ± 4.1	−0.09	0.0680	—
Postoperative hematocrit	31.6 ± 4.6	−0.24	<0.0001	0.2934
Hematocrit change	8.9 ± 3 0.7	0.18	0.0002	NI
EBL (mL)	390.4 ± 129	0.16	0.0010	0.3969
Transfusion				
No	378 (88.9)	1.5 ± 1.3	<0.0001	<0.0001
Yes	47 (11.1)	3.5 ± 2.1		

ASA = American Society of Anesthesiologists, CEW = clopidogrel, enoxaparin, or warfarin, CEWA = clopidogrel, enoxaparin, warfarin, or aspirin, DJD = degenerative joint disease, EBL = estimated blood loss, Fx = fracture, MRCT = massive rotator cuff tear, NI = not included because of similarities with other variables, RCA = rotator cuff tear arthropathy, TSA = total shoulder arthroplasty.

Comorbid Conditions

The presence of diabetes and inflammatory arthritis contributed to a longer length of hospitalization (2.4 vs. 1.7 days). Menendez et al[15] found that patients with diabetes had an increased risk of a length of stay ≥4 days in TSA, with odds ratios ranging from 1.4 to 2.27. A large epidemiological study has shown that patients with diabetes have 12.5% longer hospital stays than do patients without diabetes and greater chances of an extended hospital stay (odds ratio, 1.4).[10] In addition, patients with complicated diabetes were hospitalized longer compared with patients with uncomplicated diabetes (3.4 vs. 2.7 days, respectively).[10] Diabetes may be a surrogate marker for poor health status and may synergistically act with other comorbidities to increase complexity of care and length of hospitalization.[23,24]

Our study showed a significant increase in the length of hospitalization for patients with an ASA score of 3 or 4 in a multivariate analysis. This finding is in agreement with two studies.[8,13] One study found that an ASA score of 3 or 4 was associated with an increased length of hospitalization for TSA, RTSA, and revision arthroplasty procedures (3.3 vs. 2.6 days).[8] By contrast, other evidence shows that an ASA score of 3 or 4 was not associated with an extended length of stay (≥4 days) in patients with TSA in multivariate analysis.[12] A higher ASA score is a surrogate marker for further medical comorbidities, which correlates with a longer length of hospitalization[2] due to extended observation periods in the hospital.

We found that hospital stays were longer for patients with diagnoses of acute fracture or fracture sequelae. Patients with fracture and fracture sequelae likely had an increased length of stay because of associated injuries and more complex surgeries with a higher chance of postoperative pain. In one large database study, 71% of patients with HA and 68% of those with RTSA and TSA fracture diagnoses stayed ≥3 days in the hospital, which was the longest length of stay of all diagnoses evaluated.[14] Further research is needed to examine the factors associated with increased length of stay after shoulder arthroplasty for proximal humerus fractures or fracture sequelae.

Diagnosis of inflammatory arthritis was found to be associated with an increased length of hospitalization after shoulder arthroplasty in this study. We theorize that the longer length of stay in patients with inflammatory arthroplasty is associated with medical and pain factors associated with this systemic disease, although the results of this are mixed in the literature. In one large database study, 50% of patients with HA, TSA, and RTSA inflammatory shoulder arthritis were hospitalized ≥3 days.[14] One study using the Nationwide Inpatient Sample showed a shorter length of stay after TSA in patients with rheumatoid arthritis compared with patients without rheumatoid arthritis (2.7 vs. 3.2 days) using logistic regression analysis[6]; however, this was much longer than the length of hospitalization seen in this study.

To our knowledge, this study is the first to show that blood transfusion associated with shoulder arthroplasty leads to longer length of hospitalization using multivariate analysis. Increased length of stay associated with transfusion is likely due to continued patient and hemodynamic monitoring as well as repeated checks posttransfusion of hematocrit levels. In one large public database study, a diagnosis of "deficiency anemia" showed an approximately 2-fold increase of extended length of hospitalization after TSA and RTSA,[15] but transfusion, preoperative anemia, and postoperative anemia were not analyzed. Another large database study using the Nationwide Inpatient Sample found an increased length of hospitalization in patients with shoulder arthroplasty receiving allogeneic and autologous blood transfusions on univariate analysis (4.0 vs. 2.3 nights).[25] Preventing perioperative blood transfusion after shoulder arthroplasty may not only help to decrease the length of hospitalization but also has been shown to decrease the cost.[25]

Study Limitations

The main limitation of this study is its retrospective nature; however, a prospective research database was used. Not every factor studied was available in every patient, and the potential for errors in the database is possible. In addition, cases from one senior surgeon were evaluated; thus, results may be specific to his surgical technique.

Study Strengths

The main strength of this study was the ability to evaluate specific patient factors that cannot be evaluated in public database studies. Several perioperative factors that have not been previously reported were evaluated in this study. Preoperative hematocrit level, hematocrit level change, postoperative hematocrit level, prior shoulder surgery, and the preoperative use of anticoagulation were not shown to influence the length of hospitalization using multivariate analysis, and to our knowledge, they have not been previously examined.

Factors associated with an increased length of hospitalization in multivariate analysis were diabetes mellitus, an ASA score of 3 or 4, preoperative diagnosis of acute fracture or fracture sequelae, preoperative diagnosis of inflammatory arthropathy, and the need for a blood transfusion. Our study echoes the results of several studies, and to our knowledge, it is the first to identify that the need for a perioperative blood transfusion is independently associated with an increased length of hospitalization after shoulder arthroplasty using multivariate analysis.

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