An Original Study

Shoulder Arthroplasty: Disposition and Perioperative Outcomes in Patients With and Without Rheumatoid Arthritis

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Abstract

Shoulder arthroplasty (SA) is used to treat pain and disability associated with rheumatoid arthritis (RA). Although SA is an effective procedure in patients with RA, more investigation of perioperative outcomes is needed.

We conducted a study to compare the perioperative complication rates and demographics of patients with and without RA. Given the potential for anemia of chronic disease and the systemic inflammatory nature of RA, we hypothesized that the perioperative complication profile of RA patients would be worse than that of non-RA patients.

Data on SA patients were obtained from the Nationwide Inpatient Sample for the period 2006–2011. Of the 34,970 SA patients identified, 1674 had a primary diagnosis of RA and 33,296 did not. Demographics, hospital disposition factors, and complications were compared using regression analysis.

Analyses of 14 different perioperative outcome measures demonstrated no significant difference in any category except blood transfusions; the blood transfusion rate was significantly higher ($P < .001$) for RA patients (9.00%) than for non-RA patients (6.16%). RA patients had longer hospital length of stay (2.196 vs 2.085 days; $P < .001$), higher inflation-adjusted charges ($54,284 vs $52,663; $P = .018$), and lower home discharge rates (63.0% vs 67.6%; $P < .001$).

These results suggest that the complex nature of RA plays a role in perioperative SA outcomes. RA patients' longer hospital stays were not clinically significant. Research on postoperative care, billing practices, and hospital protocols is needed to determine the cause of these outcomes.

Shoulder arthroplasty (SA), including total SA (TSA) and reverse TSA, is an effective surgical treatment for fracture and primary or secondary degenerative disease of the shoulder.[1] Over the past few decades, use of SA has increased dramatically, from about 5000 cases in 1990 to 7000 in 2000 and more than 26,000 in 2008.[1,2]

Complications associated with SA generally are classified as perioperative (occurring during the operative index) or long-term (postdischarge).[3] Long-term complications include implant loosening, instability, revision, infection, rotator cuff tear, neural injury, and deltoid detachment.[1,4,5] Perioperative complications, which are less commonly reported, include intraoperative fracture, infection, neural injury, venous thromboembolic events (VTEs, including pulmonary embolism [PE] and deep vein thrombosis [DVT]), transfusion, and death.[3,6-10]

SA is an attractive treatment option for patients with rheumatoid arthritis (RA), as the effects of pain on these patients are greater in the shoulder joint than in any other joint.[11] Patients with RA pose unique orthopedic surgical challenges, including any combination of decreased bone mineralization, poor capsular tissue integrity, and

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osteonecrosis.[3,12] In addition, RA patients may be taking immunosuppressive medications that have severe side effects, and they may require multiple surgeries.[12,13] These factors predispose patients with RA to complications that include infection and wound dehiscence.[3,5,12-14]

The complex nature of RA has prompted investigators to examine outcome measures in this patient group. Hambright and colleagues[3] used the Nationwide Inpatient Sample (NIS) to examine perioperative outcomes in RA patients who underwent TSA between 1988 and 2005.[3] They found that TSA patients with RA had shorter and less costly hospital stays and were more likely to have a routine discharge.[3] Using the same patient population drawn from the period 2006–2011, we conducted a study to determine if this unexpected trend persists as the number of TSAs and quality of postoperative care continue to increase. Given the potential for anemia of chronic disease and the systemic inflammatory nature of RA, we hypothesized that the perioperative complication profile of RA patients would be worse than that of non-RA patients.

Materials and Methods

NIS data were acquired for the period 2006–2011. The NIS is the largest publicly available all-payer inpatient database, with a random 20% sample of about 1000 US hospitals accounting for 7 to 8 million inpatient stays. The database supplies weights used to estimate national totals, at about 35 million inpatient visits per year. NIS inpatient data are limited to the operative index. Postdischarge information is not available. The NIS is managed by the Healthcare Cost and Utilization Project, which is sponsored by the Agency for Healthcare Research and Quality. The quality of NIS data is assessed and validated by an independent contractor. NIS data have been widely used to examine perioperative outcomes.[15-17]

NIS data cover patient and hospital demographics, hospital length of stay (LOS), discharge status, payer information, charges, and perioperative outcomes and procedure/diagnosis codes (*ICD-9*; *International Classification of Diseases, Ninth Revision*[18]).

As our Institutional Review Board (IRB) reviewed the database and determined the project was not human subject research, IRB involvement was not required. This study paralleled successful efforts with similar RA and non-RA patients who had shoulder and elbow surgery.[3,19] SA patients were identified by *ICD-9* procedure code 81.80, but this code does not specify whether the prosthesis was unconstrained, semiconstrained, or constrained. *ICD-9* coding also does not specify whether the TSA was traditional or reverse. Patients with RA were identified by *ICD-9* diagnosis codes 714.0, 714.1, and 714.2. Patients without one of these codes were placed in the non-RA cohort. Patients with codes associated with pathologic fractures secondary to metastatic cancer or bone malignant neoplasm as a secondary or primary diagnosis and patients who had revision surgery indicated by code 81.83 were excluded, as they have a disproportionately higher comorbidity burden.

After each cohort was defined, demographic data (age, sex, race, income quartile based on ZIP postal code) were compared, as were data on primary payer, hospital demographics, LOS (≤5 days, defined as perioperative index), discharge type, inflation-adjusted charges in 2014 dollars based on the Consumer Price Indexes (http://www.bls.gov/cpi/), and mortality. Perioperative complications—respiratory, gastrointestinal, genitourinary, accidental puncture/laceration, central nervous system, wound dehiscence, device-related (including embolism, fibrosis, hemorrhage, pain, stenosis, or thrombus caused by any device, implant, or graft), cardiac, hematoma/seroma, acute respiratory distress syndrome, postoperative shock, VTE, postoperative infection complications, and intraoperative transfusions—were considered using *ICD-9* codes (996.X-999.X and 99.X, respectively).[20] Although commonly used to determine perioperative comorbidity burden using *ICD-9* coding, the modified Charlson index was not considered because RA is a component of the index and would therefore bias the variable.[3,21]

Statistical analyses, including χ^2 tests and 2-sample *t* tests, were performed for categorical and continuous variables, respectively. $P < .05$ was considered significant. Fisher exact test was used for cohorts with fewer than 5 occurrences. Multivariate logistic regression models were then calculated to determine the effect of RA on different outcomes and complications, with age, race, sex, hospital region, hospital type, number of hospital beds, primary payer, and hospital ownership as covariates. Statistical analyses were performed using the R statistical programming language.[22]

Results

Of the 34,970 patients who underwent SA between 2006 and 2011, 1674 (4.8%) had a diagno-

Table 1. **Demographic and Key Outcomes Data Analysis**

N = 34,970 Patients	Rheumatoid Arthritis: With n = 1674	Rheumatoid Arthritis: Without n = 33,296	*P* (χ^2 Test or *t* Test)
Age, y			
Mean (SD)	66.387 (11.394)	69.069 (9.990)	**<.001**
Median (50%)	68	70	
25%-75%	60-75	63-76	
% Female	75.51	54.41	**<.001**
Race, %			**<.001**
White	85.10	90.29	
Black	5.38	3.82	
Hispanic	5.91	3.12	
Asian or Pacific Islander	1.38	0.58	
Native American	0.23	0.41	
Other	2.00	1.78	
ZIP Postal Code Income Quartile, %			.340
1	21.39	20.64	
2	28.89	27.35	
3	25.90	27.11	
4	23.82	24.90	
Expected Primary Payer, %			**<.001**
Medicare	66.75	66.69	
Medicaid	2.87	1.84	
Private, including HMO	28.47	27.43	
Self-pay	0.18	0.36	
No charge	0.24	0.04	
Other	1.49	3.64	
Hospital Bed Size, %			.776
Small	16.26	16.74	
Medium	23.52	22.87	
Large	60.22	60.39	
Hospital Region, %			.586
Northeast	13.76	13.38	
Midwest	28.75	27.82	
South	35.45	35.55	
West	22.01	23.25	
Teaching Status, %			.816
Teaching	47.46	47.14	
Nonteaching	52.54	52.86	
Length of Stay, d			
Mean (SD)	2.196 (0.927)	2.085 (0.932)	**<.001**
Median (50%)	2	2	
25%-75%	2-3	1-3	
Died, %	0 (0.00)	27 (0.081)	.475
Routine Discharge, %	62.96	67.63	**<.001**
Inflation-Adjusted Charges, $			
Mean (SD)	54,284.46 (27,146.92)	52,663.28 (27,607.14)	**.018**
Median (50%)	48,452.60	46,723.28	
25%-75%	35,914-66,263	34,860-63,605	

Abbreviation: HMO, health maintenance organization.

sis of RA and 33,296 (95.2%) did not. On average, patients with RA tended to be younger than patients without RA (66.4 vs 69.1 years; $P < .001$), and a larger percentage of RA patients were female (75.5% vs 54.4%; $P < .001$). Compared with non-RA patients, RA patients comprised a different ethnic group and had a different expected primary payer ($P < .001$). SA patients with and without RA did not differ in income quartile based on ZIP code, total number of hospital beds, hospital region, or hospital teaching status ($P = .34$, .78, .59, and .82, respectively) (**Table 1**).

LOS was significantly ($P < .001$) statistically longer for RA patients (2.196 days) than for non-RA patients (2.085 days). RA patients were significantly less likely to be discharged home (63.0% vs 67.6%; $P < .001$). (Routine discharge was defined as discharge home, whereas nonroutine discharge was defined as discharge to a short-term hospital, skilled nursing facility, intermediate care, another type of facility, home health care, against medical advice, or death.) In addition, inflation-adjusted charges associated with SA were significantly higher ($P = .018$) for RA patients ($54,284) than for non-RA patients ($52,663) (Table 1).

Regarding the rates of complications that occurred during the perioperative index, there were no significant differences between RA and non-RA cohorts. These complications included respiratory, gastrointestinal, genitourinary, accidental puncture/laceration, central nervous system, wound dehiscence, device-related, cardiac, hematoma/seroma, acute respiratory distress syndrome, postoperative shock, VTE, and postoperative infection (**Table 2**). In addition, there was no significant difference in mortality between the groups ($P = .48$).

In TSA, blood transfusions were

more likely ($P < .001$) to be given to RA patients (9.00%) than to non-RA patients (6.16%). Multivariate regression analyses were performed with age, race, sex, hospital region, hospital type, number of hospital beds, primary payer, and hospital ownership as covariates. These analyses revealed that transfusion ($P < .001$), discharge type ($P = .002$), total inflation-adjusted charges ($P < .001$), and LOS ($P = .047$) remained significant (**Table 3**).

Discussion

Large national databases like NIS allow study of uncommon medical occurrences and help delineate risks and trends that otherwise might be indeterminable. Although it has been suggested that patients with RA may have poorer long-term outcomes after SA, the perioperative risk profile indicates that TSA is well tolerated in RA patients during the operative index.[3,23-25]

The data on this study's 34,970 patients, drawn from the period 2006–2011, demonstrated no significant differences in safety profile with respect to the 14 perioperative complications and outcomes examined, except blood transfusion rate. Rates of postoperative infection (RA, 0.24%; non-RA, 0.14%; $P = .303$), VTE (RA, 0.30%; non-RA, 0.25%; $P = .905$), and transfusion (RA, 9.00%; non-RA, 6.16%; $P < .001$) are of particular interest because of the severity of these situations.

Postoperative infection is a potentially serious complication and often occurs secondary to diabetes, RA, lupus erythematosus, prior surgery, or a nosocomial or remote source.[1] The often costly treatment options include antibiotic suppression, irrigation and debridement with implant retention, 1-stage exchange with antibiotic-impregnated cement fixation, staged reimplantation, resection arthroplasty, arthrodesis, and amputation.[1] The overall 0.14% infection rate determined in this study is lower than the 0.7% reported for SA patients in the literature.[1] Given the nature of the NIS database, this rate underestimates the true postoperative infection rate, as any infection that occurred after the perioperative period is not captured.[26] The present study's perioperative infection rates (RA, 0.24%; non-RA, 0.14%) for the period 2006–2011 are comparable to the rates (RA, 0.17%; non-RA, 0.24%) reported by Hambright and colleagues[3] for

Table 2. **Bivariate Analysis of Perioperative Complications**

	Rheumatoid Arthritis				
	With		Without		*P* (χ^2 Test or Fisher Exact Test)
Complication	**n**	**%**	**n**	**%**	
Respiratory	6	0.36	76	0.23	.415
Gastrointestinal	3	0.18	67	0.20	-
Genitourinary	5	0.30	198	0.60	.164
Accidental puncture/laceration	4	0.24	61	0.18	.554
Central nervous system	2	0.12	46	0.14	-
Wound dehiscence	0	0.00	5	0.02	-
Device-related	16	0.96	315	0.95	-
Cardiac	9	0.54	202	0.61	.846
Hematoma/seroma	6	0.36	137	0.41	.892
Acute respiratory distress syndrome	14	0.84	24	60.74	.759
Postoperative shock	0	0.00	23	0.07	.626
Venous thromboembolism	5	0.30	84	0.25	.905
Postoperative infection	4	0.24	46	0.14	.303
Transfusion	150	9.00	2049	6.16	**<.001**

the same patient population over the preceding, 18-year period (1988–2005) and similarly do not significantly differ between groups. Although infection is uncommon in the immediate perioperative period, the *ICD-9* codes used refer specifically to infection resulting from surgery and do not represent concomitant infection.

VTEs, which include PEs and DVTs, are rare but potentially life-threatening surgical complications.[27,28] Mechanical prophylaxis and chemical prophylaxis have been recommended for major orthopedic surgery, particularly lower extremity surgery, such as total hip arthroplasty (THA) and total knee arthroplasty (TKA).[28,29] In the present study, VTE rates were low, 0.30% (RA) and 0.25% (non-RA), and not significantly different in bivariate or multivariate analyses. These rates are comparable to those found in other national-database SA studies.[28] VTEs that occur outside the index hospital admission are not captured in this database. Therefore, the rates in the present study may be lower than the true incidence after SA. Mortality secondary to VTE usually occurs within 24 hours but may occur up to 90 days after surgery. DVT rates, on the other hand, are difficult to evaluate because of differences in screening practices.[27,28,30,31]

That RA patients were more likely than non-RA patients to receive perioperative blood transfusions supports prior findings that SA patients with RA were more likely than SA patients with osteoarthritis (OA) to receive perioperative blood transfusions.[8] RA patients have been shown to have high rates of anemia of chronic disease, ranging from 22% to 77%.[32] During joint replacement, these patients often require transfusions.[32,33] However, these findings differ from prior findings of no differences between RA and non-RA patients in the same patient population during the period 1988–2005.[3] This difference may be a product of the constantly changing transfusion guidelines and increased use; transfusion rates increased 140% between 1997 and 2007, making transfusions the fastest growing common procedure in the United States during that time.[34]

There was no difference between RA and non-RA patients in household income (as determined by ZIP code analysis), number of hospital beds, hospital region, or hospital teaching status. Compared with non-RA patients, RA patients were more likely to be younger, female, and of a different race and to have a different expected primary payer ($P < .001$). These findings are consistent with previous findings in the literature.[3] In the present SA study, however, RA patients were more likely than non-RA patients to have longer LOS, higher inflation-adjusted hospital charges, and nonroutine discharge. These findings deviate from those of the study covering the preceding 18 years (1988–2005).[3] Despite the findings of a changing environment of care for RA patients, by Hambright and colleagues[3] and Weiss and colleagues,[35] the trend appears to have shifted. Both groups had shorter average LOS than either group from the preceding 18 years.[3] Although statistically significant in bivariate analysis, the difference in LOS between the 2 groups differed by an average of 0.11 day (2 hours 24 minutes) and was not clinically relevant.

In addition, the higher charges for patients with RA represent a deviation from the preceding 18 years.[3] Other studies have also shown that RA is associated with increased cost in TSA.[36] Patients with RA often have rotator cuff pathology, indicating reverse SA may be used more frequently.[37,38] The increased implant cost associated with reverse SA may

Table 3. **Multivariate Analysis of Perioperative Outcomes Data and Demographics**[a]

Linear Regression Model	Odds Ratio	95% CI	*P*
Complications			
Respiratory	0.723	0.175-2.982	.654
Gastrointestinal	0.772	0.187-3.188	.720
Genitourinary	1.00	0.408-2.461	.996
Accidental puncture/laceration	1.740	0.619-4.891	.294
Central nervous system	1.470	0.349-6.193	.600
Device-related	0.541	0.266-1.104	.091
Cardiac	1.286	0.627-2.637	.493
Hematoma/seroma	0.927	0.376-2.286	.870
Acute respiratory distress syndrome	1.473	0.834-2.603	.183
Venous thromboembolism	0.591	0.144-2.43	.465
Postoperative infection	1.99	0.688-5.80	.203
Transfusion	1.427	1.165 - 1.749	**<.001**
Demographics			
Routine discharge	0.826	0.730-0.935	**.002**
Charges	1.038	1.037-1.038	**<.001**
Length of stay	1.040	1.000-1.081	**.047**

[a]Several linear regression models, including wound dehiscence, postoperative shock, and death, could not be calculated because of low incidence.

account for the increased costs in RA patients.[39] As mentioned, TSA type is not captured in the NIS database. In addition, that RA patients were less likely than non-RA patients to have routine discharge may indicate RA cases are more complex because of their complications.[1,5,14,40] A recent study of complications in RA patients (1163 who underwent THA, 2692 who underwent TKA) found that THA patients with RA were significantly more likely than THA patients with OA to dislocate, and TKA patients with RA were significantly more likely than TKA patients with OA to develop an infection after surgery.[41] Postoperative dislocation has been shown to increase hospital costs in other orthopedic procedures.[42] Also, during TSA, patients with RA are more likely than patients with OA to receive intraoperative blood transfusions.[8] These complications—combined with the fact that RA is a chronic, progressive, systemic inflammatory disease that can affect soft tissue and blood vessel wall healing and is associated with medications having potential side effects—could contribute to the apparent increased hospital charges and LOS.[3,12,13,43] Factors that include surgeon preference, impact of primary payer, and hospital practice may also affect final charges. Total charges in the NIS database include administrative fees, hospital costs, device-related costs, operating room costs, and ancillary staff costs. Total charges do not include professional fees and differ from the total cost that represents the amount reimbursed by the payer. Charges tend to correlate with but overestimate the total costs.[44]

This study had several important limitations. As mentioned, only events that occur during the operative admission are captured in the NIS database, and thus postoperative complications or serious adverse events that lead to readmission cannot be identified. In addition, outpatient TSAs are not captured in the NIS database, and thus inclusion of only inpatient procedures yields higher average LOS and total charges.[45] Given the limited granularity of *ICD-9* coding, this study could not determine RA severity, estimated blood loss, length of surgery, complication severity, type of TSA procedure/prosthesis, or cause of death. Although commonly used to determine comorbidity burden, the modified Charlson index could not be used, and therefore could not be entered as a covariate in multivariate analysis. Furthermore, the NIS database does not include imaging or patient-reported outcomes information, such as improvements in pain or function, which are of crucial importance in considering surgery.

Conclusion

Our findings corroborated findings that the demographics and the perioperative safety profile for TSA were similar for patients with and without RA. The risk for complications or death in the perioperative period was low. Compared with non-RA patients, RA patients had significantly higher charges and longer LOS and were less likely to be discharged home after surgery. The 0.11-day difference in LOS, though statistically significant, was not clinically relevant. These findings differ from those for the preceding, 18-year period (1988–2005). Future research should focus on the causes of these changes.

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