Perioperative complications after hemiarthroplasty and total shoulder arthroplasty are equivalent

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**Background:** Total shoulder arthroplasty (TSA) results in superior clinical outcomes to hemiarthroplasty (HA); however, TSA is a more technical and invasive procedure. This study retrospectively compares perioperative complications after HA and TSA using the National Surgical Quality Improvement Program (NSQIP) database.

**Methods:** The NSQIP user file was queried for HA and TSA cases from the years 2005 through 2010. Major complications were defined as life-threatening or debilitating. All complications occurred within 30 days of the initial procedure. We performed multivariate analysis to compare complication rates between the two procedures, controlling for patient comorbidities.

**Results:** The database returned 1,718 patients (HA in 30.4% [n = 523] and TSA in 69.6% [n = 1,195]). The major complication rates in the HA group (5.2%, n = 29) and TSA group (5.1%, n = 61) were similar (P = .706). Rates of blood transfusions for postoperative bleeding in patients undergoing HA (2.3%, n = 12) and TSA (2.9%, n = 35) were indistinguishable (P = .458). Venous thromboembolism was a rare complication, occurring in 0.4% of patients in each group (2 HA patients and 5 TSA patients, P > .999). On multivariate analysis, the operative procedure was not associated with major complications (P = .349); however, emergency case, pulmonary comorbidity, anemia with a hematocrit level lower than 36%, and wound class of III or IV increased the risk of a major complication (P < .05 for all).

**Conclusion:** Multivariate analysis of patients undergoing TSA or HA in the NSQIP database suggests that patient factors—not the procedure being performed—are significant predictors of major complications. Controlling for patient comorbidities, we found no increased risk of perioperative major complications in patients undergoing TSA compared with HA.

**Level of evidence:** Level III, Retrospective Cohort Design, Treatment Study.

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**Keywords:** Perioperative; hemiarthroplasty; total shoulder arthroplasty; complications

Hemiarthroplasty (HA) and total shoulder arthroplasty (TSA) have been used to successfully treat traumatic and nontraumatic conditions of the shoulder. As a result, the number of HA and TSA cases has been increasing exponentially. In 2000, roughly 11,000 HA and 7,200 TSA cases were performed in the United States. By 2008, the number of HAs increased to about 20,000 whereas the number of TSA cases surged to roughly 27,000, with 43% of HAs and 77% of TSAs being performed for degenerative conditions. Factors that influence the operative procedure include patient age, comorbidities, radiographic findings, and surgeon experience.
Recent studies have shown that TSA results in superior outcomes to HA in the treatment of glenohumeral osteoarthritis of the shoulder. In fact, the American Academy of Orthopaedic Surgeons now recommends TSA over HA, when the indications are appropriate, for the treatment of glenohumeral osteoarthritis. However, the potential advantages of HA include a shorter operative time, less blood loss, lower initial cost, and less technical difficulty. The literature does suggest that more perioperative complications, especially infection, are associated with longer procedures and increasing blood loss. However, large cohort studies comparing perioperative complications between HA and TSA have yet to be conducted.

A few studies have specifically compared the rates and types of complications associated with HA and TSA. However, these cohorts were small, a limited number of complications were reported, and analysis of multiple variables was not used. The current literature lacks large database studies that help identify patients at risk of complications when undergoing HA or TSA. Such studies would help guide future initiatives to improve quality of care and decrease costs.

The purpose of this study was to query the National Surgical Quality Improvement Program (NSQIP) database and examine 30-day adverse outcomes reported for HA and TSA to compare rates of complications after the two procedures performed for any indication. We hypothesized that there is no difference in 30-day perioperative complication rates between the two procedures.

Materials and methods

The American College of Surgeons NSQIP Participant User File comprises a clinical database with systematic patient tracking at hospitals that voluntarily participate. The sampling strategy, data abstraction, and included variables have been previously described. We retrospectively queried the NSQIP database from 2005 through 2010 for patients meeting the following inclusion criteria: patients aged older than 16 years with Common Procedural Terminology (CPT) codes for TSA and HA (CPT code 23472 and CPT code 23470, respectively). Patients with missing information regarding age or sex were excluded. A total of 1,718 patients met our criteria.

Preoperative comorbidities were grouped by organ system, as previously described: cardiac comorbidity, neurologic comorbidity, respiratory comorbidity, renal insufficiency, and hepatic insufficiency. The American Society of Anesthesiologists (ASA) classification of disease status was grouped as III, IV, and V compared with I and II. The NSQIP database provides wound classification in accordance with the Centers for Disease Control and Prevention (wound class of I designates clean cases; II, clean-contaminated cases; III, contaminated cases; and IV, dirty/infected cases). Laboratory values were captured as the last recorded values within 90 days before surgery. Albumin level and anemia were evaluated as categorical variables with thresholds of 3.5 g/dL and a hematocrit level lower than 36%, respectively. Preoperative transfusion was also evaluated using the parameter collected by the NSQIP database representing greater than 4 U of blood transfused within 72 hours before the index procedure. A bleeding disorder was defined as any condition putting the patient at risk of bleeding due to a deficiency of blood clotting elements, that is, vitamin K deficiency, hemophilia, thrombocytopenia, or use of chronic anticoagulants (not including aspirin) in the perioperative period. The preoperative functional status specifies the patient’s self-care level for activities of daily living observed in the 30 days before surgery and was defined as dependent or independent.

The methodology for outcome classification has been previously published according to the Clavien-Dindo schema. Major complications included the following: organ space infection, sepsis, postoperative bleeding requiring transfusion, dependence on a ventilator (reintubation or failure to wean), cardiac event, neurologic event, pneumonia, venous thromboembolic event, return to the operating room, graft failure, or acute renal failure. Return to the operating room was recorded as any unplanned major surgical procedure within the 30-day postoperative period that was a result of an adverse outcome related to the principal procedure. Minor complications were defined as incisional infection (superficial to the fascia) and urinary tract infection.

Clinical characteristics were assessed for association with endpoints, including major complications, postoperative bleeding, length of stay, and operative time. Bivariate analysis was performed with the Student t test or Pearson χ² analysis as appropriate. Factors with P < .1 were included in the multivariate analysis. The significance for multivariate predictors of each endpoint was set at a 2-tailed P value equal to .05. Patients with any missing data (eg, albumin level) during multivariate analysis were included via imputing. Unknown variables were combined with the reference group, which underestimates their effect, resulting in a more conservative analysis. All analyses were carried out with IBM SPSS Statistics software, version 19 (IBM, Armonk, NY, USA).

Results

The NSQIP database returned 1,718 patients who underwent either HA (30.4%, n = 523) or TSA (69.6%, n = 1,195). Men comprised 43.3% (n = 225) and 42.5% (n = 507) of the HA and TSA groups, respectively (P = .77). The mean age was 65.6 ± 14.1 years for the HA group and 68.6 ± 11.3 years for the TSA group (P < .001). Race distribution (P = .358), transfer from an outside facility (P = .056), hematocrit level lower than 36% (P = .051), preoperative transfusion (P = .093), history of chemotherapy or radiation (P = .51), bleeding disorders (P = .271), chronic steroid use (P = .184), neurologic comorbidity (P = .357), renal insufficiency (P = .210), cardiac comorbidity (P = .479), alcohol dependency (P = .058), history of diabetes mellitus (P = .672), and number of individuals with body mass index over 30 (P = .379) did not differ between the two groups. Surgery was performed for nontraumatic indications in 93.7% of HA patients and 96.5% of TSA patients (Table 1).

Compared with the TSA group, the HA group had more patients with preoperative sepsis (1.9% in HA group...
vs 0.4% in TSA group, \( P = .004 \); more ASA class III, IV, or V patients (57.3% in HA group vs 45.4% in TSA group, \( P < .001 \)); more emergency cases (2.9% in HA group vs 0.3% in TSA group, \( P < .001 \)); more patients with pulmonary comorbidity (8.6% in HA group vs 4.3% in TSA group, \( P < .001 \)); and more smokers (20% in HA group vs 6.5% in TSA group, \( P < .001 \)).

The overall 30-day major complication rate was 5.2% (\( n = 90 \)). The major complication rates in the HA group (5.2%, \( n = 29 \)) and TSA group (5.1%, \( n = 61 \)) were similar (\( P = .706 \)). Hospital length of stay was statistically longer in the HA group (2.49 ± 2.56 days) than in the TSA group (2.23 ± 1.72 days) (\( P = .032 \)) on univariate analysis, but after we controlled for differences in patient characteristics on multivariate analysis, there was no longer a significant difference (\( P = .316 \)). Rates of blood transfusions for postoperative bleeding in patients undergoing HA (2.3%, \( n = 12 \)) and TSA (2.9%, \( n = 35 \)) (\( P = .458 \)) were the same. Rates of incisional infection were low: 0.2% for HA (\( n = 1 \)) and 0.3% for TSA (\( n = 3 \)) (\( P = .81 \)). Venous thromboembolism was a rare complication, occurring in 0.4% of patients in each group (2 HA patients and 5 TSA patients, \( P > .999 \)). Rates of return to the operating room were higher for the HA group (1.7%, \( n = 9 \)) compared with the TSA group (0.7%, \( n = 8 \)) (\( P = .043 \)).

Multivariate analysis showed no difference in major complication rates 30 days after surgery between HA and TSA patients (\( P = .319 \)), after adjustment for emergency case, age, sex, smoking, ASA class, functional status, pulmonary comorbidity, preoperative transfusion, preoperative sepsis, hypoalbuminemia, anemia, and wound class. The patient characteristics associated with an increased adjusted odds of 30-day major complications were emergency case (odds ratio [OR], 3.7; \( P = .03 \)), pulmonary comorbidity (OR, 2.19; \( P = .03 \)), anemia with a hematocrit level lower than 36% (OR, 2.09; \( P = .001 \)), and wound class of III or IV (OR, 4.92; \( P = .006 \)) (Table II).

Nontraumatic diagnosis codes included osteoarthrosis, aseptic necrosis, rotator cuff disease, joint infection, and implant failure. Traumatic diagnosis codes included periprosthetic fracture, native proximal humeral fracture, and dislocation.

### Discussion

Data on perioperative complications from large cohorts after HA and TSA are lacking. The purpose of this study was to examine 30-day postoperative complications after HA compared with TSA. Using the NSQIP database, we were able to study a large number of patients, and on the basis of multivariate analysis, these data suggest that there are no differences in major perioperative complications between these two surgical procedures. Previous studies have reported similar perioperative complication rates between the two procedures; however, the cohorts were small, fewer variables were reported, and multivariate analysis was not used.5,6,14

The differences in the characteristics between the HA and TSA cohorts in this study suggest that many surgeons recommend HA for patients with more comorbidities. Patients undergoing HA were more likely to be smokers, have preoperative sepsis, have higher ASA scores, and have a pulmonary comorbidity, as compared with the TSA group. Furthermore, HA was performed as an emergency case more often than TSA. Controlling for these factors with multivariate analysis in this study suggests that patient factors are the important predictors of major complications, and the procedure chosen does not increase the risk of adverse outcomes. Our data suggest that emergency case, pulmonary comorbidity, anemia with a hematocrit level lower than 36%, and wound class of III or IV are stronger predictors of complications than the actual operation performed, with regard to HA and TSA.

Previously reported rates of venous thromboembolism have been reported as 0.04% for arthroscopic shoulder surgery, 0.45% for shoulder replacement, and 0.8% for shoulder HA in the setting of a fracture.7 The rate in this study for HA and TSA was 0.4%, which is consistent with previous reports.

Recent literature has suggested superior results with TSA compared with HA for the treatment of glenohumeral osteoarthritis.11 Patients undergoing TSA reported better functional outcomes, pain relief, mobility, overall satisfaction, and strength compared with HA patients.1,5,19,22,24

### Table I Indications for surgery in both groups of patients

<table>
<thead>
<tr>
<th>Indication for surgery</th>
<th>HA (n = 523)</th>
<th>TSA (n = 1,195)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on reported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICD-9 code</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nontraumatic</td>
<td>93.7% (n = 490)</td>
<td>96.5% (n = 1,153)</td>
</tr>
<tr>
<td>Traumatic</td>
<td>6.3% (n = 33)</td>
<td>3.5% (n = 42)</td>
</tr>
</tbody>
</table>

**Table II Multivariate analysis of major complications**

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR 95% Confidence interval</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSA vs HA</td>
<td>1.29 (0.78-2.12)</td>
<td>.319</td>
</tr>
<tr>
<td>Age</td>
<td>1.00 (0.98-1.02)</td>
<td>.828</td>
</tr>
<tr>
<td>Emergency case</td>
<td>3.70 (1.11-12.35)</td>
<td>.033</td>
</tr>
<tr>
<td>Transfer from outside facility</td>
<td>2.39 (0.68-8.44)</td>
<td>.176</td>
</tr>
<tr>
<td>Dependent functional status</td>
<td>1.70 (0.82-3.52)</td>
<td>.157</td>
</tr>
<tr>
<td>ASA class III, IV, or V</td>
<td>1.48 (0.91-2.39)</td>
<td>.114</td>
</tr>
<tr>
<td>Smoker</td>
<td>1.06 (0.51-2.19)</td>
<td>.874</td>
</tr>
<tr>
<td>Alcohol dependency</td>
<td>1.42 (0.41-4.87)</td>
<td>.58</td>
</tr>
<tr>
<td>Pulmonary comorbidity</td>
<td>2.19 (1.08-4.45)</td>
<td>.03</td>
</tr>
<tr>
<td>Preoperative transfusion</td>
<td>2.98 (0.06-145.68)</td>
<td>.583</td>
</tr>
<tr>
<td>Preoperative sepsis</td>
<td>1.44 (0.20-10.27)</td>
<td>.716</td>
</tr>
<tr>
<td>Anemia (hematocrit level &lt;36%)</td>
<td>2.09 (1.34-3.25)</td>
<td>.001</td>
</tr>
<tr>
<td>Wound class (III or IV)</td>
<td>4.92 (1.59-15.17)</td>
<td>.006</td>
</tr>
</tbody>
</table>

**ICD-9, International Classification of Diseases, Ninth Revision.**

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Our study adds to this body of data, suggesting that hesitation about performing TSA for fear of increased complications in the perioperative period is not warranted. It is the patient factors that may influence complications, not the procedure choice.

The weaknesses of this study include its retrospective nature and the various International Classification of Diseases, Ninth Revision code diagnoses reported as indications for surgery. Our review was limited by the database to the first 30 days postoperatively for complication analysis. We were also unable to determine the indications for patients returning to the operating room, which would be valuable to report. The CPT code for TSA (23472) includes traditional and reverse shoulder arthroplasty. The database does not differentiate between the two different procedures, and therefore our TSA cohort includes an unknown number of reverse shoulder arthroplasty procedures. Some patients may have been missing data points, such as albumin level, in the multivariate analysis. These patients were included via imputing, which has been shown to have minimal effect on risk assessment from the NSQIP database. Though retrospective in nature, this study reviews a large number of patients in each group from a national database, which improves the accuracy and applicability of these results. Some trauma patients were included in the analysis, but over 90% of patients in each group were treated for nontraumatic conditions (ie, avascular necrosis and degenerative conditions). Despite these limitations, this study is the largest series comparing HA and TSA in terms of perioperative complications, using the validated NSQIP database.

Conclusions

Multivariate analysis of the NSQIP database suggests that emergency case, pulmonary comorbidity, anemia with a hematocrit level lower than 36%, and wound class of III or IV are significant predictors of major complications in patients undergoing HA or TSA. Controlling for patient comorbidities, we found no increased risk of perioperative major complications in patients undergoing TSA compared with HA. This suggests that patient comorbidities should not influence the choice of HA or TSA for patients with shoulder disorders. This knowledge may help clinicians counsel patients about potential risks of surgery, as well as guide future initiatives to improve quality of care and decrease costs.

Disclaimer

Ilya Voloshin is a paid consultant for Zimmer, Pfizer, and Acumed and receives speaking fees from Arthrex and Acumed. All the other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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