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Risk factors associated with blood transfusion after shoulder arthroplasty

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Background: Closed-suction drainage has been studied extensively in hip and knee arthroplasty literature. However, little is known about outcomes in patients treated with drainage after shoulder arthroplasty, particularly relative to transfusion requirements.

Methods: All primary total and reverse total shoulder arthroplasties (TSAs and RSAs) performed at a single institution during a 5-year period were retrospectively reviewed. Data collected included patient demographic information, estimated blood loss (EBL), drain output, length of drain use, changes in hemoglobin (Hgb) level postoperatively, transfusions, and complications. A multivariable regression analysis was performed to identify independent risk factors for transfusion.

Results: There were no differences in surgery duration, EBL, or complications between TSA and RSA patients ($P > .05$). Patients undergoing RSA were older (74.0 vs. 68.4 years; $P < .001$) and had lower preoperative and postoperative Hgb levels ($P < .001$) compared with TSA patients. Reverse arthroplasty was also associated with longer hospital stays (2.8 vs. 2.2 days; $P < .001$), longer drain durations (1.6 vs. 1.2 days; $P < .001$), increased total wound drainage (209 vs. 168 m; $P = .006$), and higher transfusion rates (11.7% vs. 3.1%; $P = .002$). Independent risk factors for transfusion included low preoperative Hgb levels in both TSA ($P = .024$) and RSA ($P = .002$) and higher EBL in TSA ($P = .031$).

Conclusion: Low preoperative Hgb level is an independent risk factor for requiring blood transfusion after TSA and RSA. Increased wound drainage was not a risk factor for transfusion, and the 40-mL increase in wound drainage found in RSA is of questionable clinical significance.

Theoretical benefits of closed-suction drainage in orthopedic surgery include reduction in hematoma and effusion formation, improved healing, and reduced infection risk.[1,14,21,30] However, drain use has also been correlated to increased blood transfusion and infection risks postoperatively without providing clear wound healing benefits.[5,27-29] In hip and knee arthroplasty, significant research has been undertaken to better clarify the clinical impact of closed-suction drainage. Interestingly, such an intense level of research has not been applied to patients undergoing shoulder arthroplasty. Given routine use of drains in many of these patients,[9,17,19] research regarding the impact of drain use is warranted.

Transfusion in shoulder arthroplasty has garnered significant attention in recent years. A national epidemiologic study of shoulder arthroplasties, including total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (RSA), revealed an overall blood transfusion rate of 6.7%.[22] The same study cited a number of prior investigations to determine that there is a large range of blood transfusion rates published in the literature: 4.3% to 43%.[2,11,13,18,22,24,26] Multiple independent risk factors for blood transfusion in shoulder arthroplasty have been identified in these studies and include advanced age, female gender, low preoperative hemoglobin (Hgb) level, race, implantation of RSA, and increased estimated blood loss (EBL). Furthermore, Hardy et al found a higher frequency of postoperative drain use in patients requiring transfusion in a heterogeneous population of shoulder arthroplasty patients but did not report on which arthroplasties investigated (TSAs, RSAs, hemiarthroplasties, and revision arthroplasties) received a drain or on the amount of postoperative drain output.[13] As such, to our knowledge, no study has specifically investigated the risk of drain output on postoperative blood transfusion among a homogeneous group of patients.

The goal of this study was 2-fold; we sought to provide descriptive data comparing closed-suction drainage in TSA and RSA and to confirm and further identify factors associated with transfusion

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requirement after TSA and RSA. We hypothesized that patients undergoing RSA would have higher amounts of drain output than patients undergoing TSA and that patients with increased amounts of drainage postoperatively would have a higher likelihood of requiring a blood transfusion.

Materials and methods

All primary TSAs and RSAs performed between April 2009 and April 2014 at a single, tertiary care academic medical center were identified and retrospectively reviewed. Patients were selected from billing records identifying TSA and RSA patients by *Current Procedural Terminology* codes. Patients with complete records with respect to preoperative blood counts and blood collection into drainage canisters were included for review. Patients undergoing revision arthroplasty, hemiarthroplasty, or resurfacing or with incomplete records were excluded. Of the 448 arthroplasties performed during this time, 370 patients representing a total of 258 TSAs and 128 RSAs satisfied all inclusion and exclusion criteria. A combination of different implants was used, including arthroplasties from Arthrex (Naples, FL, USA), Zimmer (Warsaw, IN, USA), and Tornier (Bloomington, MN, USA). In our institution, closed-suction drainage is routinely used in shoulder arthroplasty with a 400-mL Davol closed wound suction evacuator (C.R. Bard, Inc., Covington, GA, USA). The drain was positioned deep to the deltopectoral interval with the suction tubing exiting laterally. Drains were removed when the output was <30 mL during a 12-hour period or at the attending orthopedic surgeon's discretion. All patients received postoperative deep venous thrombosis (DVT) prophylaxis with bilateral lower extremity Venodynes (Ecolab, St. Paul, MN, USA), early ambulation, and chemoprophylaxis, the standard of which consisted of aspirin 325 mg twice daily starting on postoperative day (POD) 1 for 2-4 weeks based on the surgeon's preference.

For each patient, the following data were collected: age, gender, procedure (primary TSA or RSA), preoperative and postoperative Hgb levels, length of surgery (determined by anesthesia records of time spent in the operating room), EBL as estimated by the attending orthopedic surgeon and anesthesiologist, hospital duration, drain output, and drain duration. Postoperative blood transfusion events as well as units transfused were noted as well. In addition, perioperative complications including superficial and deep infection, persistent wound bleeding or drainage, persistent swelling, ecchymosis, hematoma, wound dehiscence, DVT, pulmonary embolism, mortality, and reoperation within 1 year from the initial surgery were noted. The decision to transfuse postoperatively was clinically based and made by the treating surgical team along with medical consultation where appropriate.

Statistical analyses were performed using GraphPad Prism version 6.0e (GraphPad Software, San Diego, CA, USA) and R 3.1.2. Statistical significance was determined using a Student 2-tailed *t*-test when comparing the means of 2 or more groups or χ^2 test when analyzing continuous data. Multivariate logistic regression analyses were performed to identify risk factors associated with probability of transfusion in both TSA and RSA patients. Statistical significance was set at $P \leq .05$.

Results

A total of 370 arthroplasty patients (258 TSAs, 128 RSAs) were included in this study. Fifteen patients underwent bilateral TSA, and 1 patient underwent bilateral RSA. Demographic information for these patient groups can be found in Table I. Patients undergoing TSA were younger (68.4 vs. 74.0 years; $P < .001$) and more commonly male (49.2% vs. 29.7%; $P = .018$). There were no differences in surgical duration or EBL between the 2 groups. RSA was associated with a 0.6-day increase in length of stay ($P = .001$). Patients undergoing TSA had higher preoperative Hgb levels, 13.5 vs. 12.5 g/dL for RSA patients ($P < .001$; Table II). The average Hgb levels were also significantly lower in RSA patients immediately postoperatively (POD0) and on POD1 and POD2.

RSA patients had higher total wound drain output compared with TSA patients (209 vs. 168 mL; $P = .006$; Table III). The duration of drainage in RSA patients was 1.6 days compared with 1.2 days for TSA ($P < .001$). There were no differences in the drainage output recorded immediately postoperatively in the postanesthesia care unit.

The transfusion rates for TSA and RSA were 3.1% and 11.7%, respectively ($P = .002$; Table IV). There was no difference in the average number of units transfused or the timing of transfusion. When transfusions were excluded, there were a similar number of postoperative complications between both groups, 6.20% and 6.25% for TSA and RSA, respectively (Table V).

Comparisons were made between patients in each cohort who received a transfusion compared with those who did not (Table VI). TSA patients who required transfusions had an average preopera-

Table I
Patient demographic and surgical information

	TSA	RSA	*P* value
No. of patients	258	128	
Age, y	68.4 ± 10.36	74.0 ± 10.35	<.001*
Gender, male	49.2%	29.7%	.018*
Surgery duration, h	3.5 ± 0.7	3.4 ± 1.1	.301
EBL, mL	220.4 ± 162.3	243.1 ± 157.0	.192
Hospital duration, d	2.2 ± 0.4	2.8 ± 0.6	<.001*

TSA, total shoulder arthroplasty; *RSA*, reverse total shoulder arthroplasty; *EBL*, estimated blood loss.
Continuous variables are presented as mean ± standard deviation.

Table II
Measurement of baseline and postoperative hemoglobin levels

	TSA	RSA	*P* value
Preoperative	13.5 ± 1.7	12.5 ± 1.6	<.001*
POD0	12.0 ± 1.6	11.0 ± 1.6	<.001*
POD1	10.9 ± 1.4	10.0 ± 1.5	<.001*
POD2	10.7 ± 1.5	9.7 ± 1.4	<.001*

TSA, total shoulder arthroplasty; *RSA*, reverse total shoulder arthroplasty; *POD*, postoperative day.
Values are reported as hemoglobin levels (g/dL) ± standard deviation.

Table III
Closed-suction drainage data

	TSA	RSA	*P* value
Drain duration, d	1.2 ± 0.4	1.6 ± 0.6	<.001*
Total drain output, mL	167.6 ± 131	208.7 ± 149	.006*
Drain output recorded by PACU, mL	110.0 ± 76	107.4 ± 70	.768
Percentage of total drain output recorded in PACU	58.3%	54.1%	.184

TSA, total shoulder arthroplasty; *RSA*, reverse total shoulder arthroplasty; *PACU*, postanesthesia care unit.
Continuous variables are presented as mean ± standard deviation.

Table IV
Transfusion events

	TSA	RSA	*P* value
Patients transfused	8 (3.1%)	15 (11.7%)	.002*
Average number of units transfused	1.5 ± 0.5	1.7 ± 0.6	.364
Average POD of transfusions	1.0 ± 0.8	1.9 ± 1.6	.155

TSA, total shoulder arthroplasty; *RSA*, reverse total shoulder arthroplasty; *POD*, postoperative day.
Continuous variables are presented as mean ± standard deviation.