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Malnutrition: a marker for increased complications, mortality, and length of stay after total shoulder arthroplasty

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Background: Malnutrition is an established risk factor for postoperative complications. The purpose of this investigation was to determine the overall prevalence of malnutrition in total shoulder arthroplasty (TSA) patients, the differences in prevalence across obesity subgroups, and the overall complication risk of malnourished patients compared with normal patients.

Methods: The American College of Surgeons National Surgical Quality Improvement Program database was queried for TSA cases from 2005 to 2013 for this retrospective cohort study. Malnutrition was defined as preoperative albumin concentration of <3.5 g/dL. Rates of postoperative complications were compared between normal and malnourished patients.

Results: We identified 4,655 TSA cases, with preoperative albumin measurements available for 1681 patients (36.1%). Propensity score adjustment successfully reduced selection bias, with adjusted P values of >.05 for demographics, body mass index, and modified Charlson Comorbidity Index. Of the cohort with albumin measurements, 7.6% of patients were malnourished according to our criteria. Bivariate analysis showed malnourished patients had higher rates of pulmonary complications, anemia requiring transfusion, extended length of stay (LOS), and death (all $P < .05$). Propensity-adjusted multivariable logistic regression demonstrated that malnutrition was significantly associated (all $P < .05$) with postoperative transfusion (odds ratio, 2.49), extended LOS (odds ratio, 1.69), and death (odds ratio, 18.09).

Conclusion: The overall prevalence of malnutrition was 7.6%. Malnourished patients were at a significantly increased risk for blood transfusion, longer hospital LOS, and death within 30 days of surgery. Multivariable analysis showed TSA patients with preoperative albumin levels of <3.5 g/dL are at much higher risk for morbidity and death after surgery than patients with albumin levels within normal reference ranges.

Level of evidence: Level III, Retrospective Cohort Study using Large Database, Treatment Study.

Keywords: Albumin; shoulder arthroplasty; malnourished; obesity

This study used data from the National Surgical Quality Improvement Program, with no human identifying information, and was thus exempt from Investigational Review Board approval.

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Malnutrition is an important medical comorbidity. The prevalence of malnutrition in surgical patients has been estimated to range from 25% to 40%, with many of these patients having complication rates as high as or higher than patients with diabetes and obesity.[11,27] The negative effect

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of nutritional deficiencies on postoperative outcomes has been well documented in other surgical fields, including transplant surgery, vascular surgery, general surgery, and gynecology.[2,10,16,19,39] Initial orthopedic studies reported poor results in nutritionally deficient hip fracture patients, demonstrating significantly increased complications and longer rehabilitation times.[33,35,38] More recently, the orthopedic literature has investigated this phenomenon in spine surgery and joint arthroplasty. For spine patients with nutritional deficiency, studies demonstrate a significant increase in major postoperative medical complications, impaired wound healing, delayed postoperative recovery, and increased hospital length of stay (LOS).[17,24,37] Nutritional deficiency has been extensively investigated in hip and knee arthroplasty, with findings of up to a 5-fold increase in joint infection, wound drainage, and neurovascular and renal complications.[18,25,26,41,42]

To our knowledge, no study has evaluated the effects of nutritional status in shoulder arthroplasty, although numerous studies to date have focused on obesity rather than malnutrition.[5,22,34,36] Although it may seem counterintuitive, many obese patients are also malnourished,[41] and the adverse effects of malnutrition must be considered preoperatively in this population.[25,48] Furthermore, poor nutritional status is often subclinical, without physical manifestations until it is severe, and normal-weight patients can be malnourished without physical examination findings.

Common laboratory tests to assess nutritional status include albumin levels, transferrin levels, and total lymphocyte count.[6,21] The common standard for the total serum lymphocyte count is <1500 cells/mm^3, though the validity of this test has been questioned.[12,30] Albumin levels are more frequently used as a biomarker, with levels of <3.5 g/dL suggesting poor nutrition.[14,43] This value is used regularly in the orthopedic literature to identify malnutrition as a risk factor for poor postoperative outcomes.[14,17,42]

The purposes of the study were to (1) examine the overall prevalence of malnutrition in the total shoulder arthroplasty (TSA) population, (2) determine the overall complication risk of malnourished (albumin <3.5 g/dL) compared with nonmalnourished (albumin ≥ 3.5 g/dL) patients, and (3) evaluate the prevalence of concomitant obesity in malnourished patients.

Materials and methods

This was a retrospective cohort study using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database. TSA cases were identified from the database using Current Procedural Terminology (CPT; American Medical Association, Chicago, IL, USA) code 23472, from 2005 to 2013. This CPT code covers anatomic and reverse TSA. The study excluded patients who underwent emergency surgery, had preoperative contaminated wound classifications, and missing data including age, sex, height, and weight. An initial total of 4796 TSA patients were identified by the NSQIP database. After application of the exclusion criteria, as noted above, 4655 patients were included in the cohort.

The NSQIP database[3] is a large multicenter clinical outcomes program, with prospectively collected and risk-adjusted patient demographic and comorbidity data, preoperative laboratory results, anthropometric values, and perioperative information. Postoperative adverse events and complications are gathered up to postoperative day 30, irrespective of the date of discharge. More than 135 preoperative, intraoperative, and postoperative variables are collected prospectively from medical records, operative reports, and patient interviews.

Patient characteristics collected from the database included age, sex, height, weight, and comorbidity data. Body mass index (BMI) was calculated from height and weight. Cardiac comorbidities included myocardial infarction (within 6 months before admission), congestive heart failure (within 30 days before admission), percutaneous coronary intervention, cardiac surgery, or angina (within 1 month before admission). Pulmonary comorbidities included a history of severe chronic obstructive pulmonary disease, current pneumonia, or an assisted ventilation requirement within 48 hours before surgery. Peripheral vascular disease was defined as a history of rest pain, gangrene, or revascularization or amputation for peripheral vascular conditions. Smoking history (current smoker within the past year) and chronic steroid use (within 30 days before surgery) were also evaluated. A modified Charlson Comorbidity Index (CCI) adapted for the NSQIP was used to characterize the overall health of the patients and has been used previously in the literature.[7,8]

Patient demographics, obesity classifications, and modified CCI were compared between patients with and without preoperative serum albumin measurements. To adjust for selection bias in the patients with albumin measurements, propensity scores were determined and defined as the conditional probability of having a preoperative albumin measurement based on the observed demographic characteristics, obesity classification, and comorbidity burden. Propensity scores have been used in the literature extensively for this purpose.[4,15] Propensity-adjusted P values for preoperative patient characteristics were reported. The propensity adjustment successfully reduced selection bias by eliminating differences in preoperative variables (all $P > .05$). The remainder of the analysis was carried forward with propensity scores, using only patients with albumin measurements.

Patients were categorized by preoperative serum albumin concentration as normal albumin (≥ 3.5 g/dL) or hypoalbuminemic (<3.5 g/dL), the latter indicating malnutrition for the purpose of this study. Patients were also categorized based on BMI using the World Health Organization (WHO) classification[49]: underweight (BMI <18.5 kg/m^2), normal weight (BMI 18.5-24.9 kg/m^2), overweight (BMI 25.0-29.9 kg/m^2), obese I (BMI 30.0-34.9 kg/m^2), obese II (BMI 35.0-39.9 kg/m^2), and obese III (BMI ≥ 40.0 kg/m^2).

The study end points included any postoperative complication, major complications, minor complications, and extended LOS, which was defined as more than 3 days. Major complications included cardiac complications (cardiac arrest or myocardial infarction), central nervous system complications (stroke or coma), pulmonary complications (pneumonia, intubation, or ventilator requirement), renal complications (acute renal