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The Effect of Malnutrition and Morbid Obesity on Complication Rates Following Primary Total Joint Arthroplasty

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Introduction

The association with malnutrition and obesity and its impact on outcomes after TJA is not clear. Some studies have shown an association with obesity and malnutrition leading to increased rated of periprosthetic infection and persistent wound drainage.[1,2] While some orthopaedic surgeons consider both morbid obesity and malnutrition to be modifiable risk factors, however the effect of correcting these risk factors prior to elective TJA has yet to be addressed in the literature. Whether or not obesity and/or malnutrition independently predict complication rates is not well defined. What predisposes patients to short-term complications after primary TJA: low serum albumin, high BMI, or both?

We sought to further identify independent risk factors leading to complications after primary TJA and to correlate those factors with readmission rates and post-operative complications leading to a return to the operating room. The purpose of our study was to determine if any association between malnutrition and morbid obesity exists and if malnutrition and morbid obesity independently increase complications following primary TJA.

Materials and Methods

We retrospectively reviewed a consecutive series of patients who underwent elective primary hip or knee replacement surgery at a single high-volume academic center from June 2013 to December 2013. Nutritional markers are routinely obtained as part of each patient's preoperative medical evaluation within 30 days of the procedure. Patients were categorized as malnourished if the preoperative serum albumin was less than 3.5 mg/dL and morbidly obese if their body mass index (BMI) was greater than 40 kg/m^2 based on the World Health Organization classification of obesity.[3,4,5]

Medical comorbidities, demographics, postoperative complications, and 90-day readmission rates were documented for each patient from the electronic medical record. We defined a postoperative complication based on the classification published by Sink *et al*.[6] Grade I complications such as constipation, postoperative nausea, and fever that resolved without treatment were excluded. We also recorded reasons for return to the operating room for the duration of the study period, but limited follow-up for postoperative medical complications to 90 days, as any medical condition after this period was likely unrelated to the index surgery. Surgical complications were followed for a minimum of 6 months.

An *a priori* power analysis was conducted to determine the appropriate sample size for the study. Because our primary outcome variable of postoperative complication was binary, we analyzed the data with univariate and multivariate logistic regression. Univariate logistic regression analysis was then performed to identify risk factors for complications. To control for confounding variables, we then performed multivariate logistic regression to determine if morbid obesity and malnutrition are independent risk factors for complications after primary total joint procedures.

Results

Morbidly obese patients were more likely to be malnourished than non-morbidly obese patients (19% vs. 11%, $p = 0.010$). Among patients with normal nutritional status, morbidly obese patients had no significant difference in complication rates than non-morbidly obese patients (7% vs. 8%, $p = 0.661$). Malnourished morbidly obese patients also had no difference in complication rate than malnourished patients with a BMI < 40 kg/m2 (29% vs. 25%, $p = 0.726$). Differences in complications grouped by morbid obesity and malnutrition are listed in table 2.

When compared to patients with normal nutritional status, malnourished patients were more likely to have a postoperative complication (27% vs. 8%, $p < 0.001$), ICU intervention (14% vs. 2%, $p < 0.001$), return to OR (8% vs. 3%, $p = 0.008$), and 90-day readmission (17% vs. 4%, $p < 0.001$). Patients who were malnourished were more also likely to return to the OR for infection than patients with normal nutritional status (6% vs. 0.3%, $p = 0.004$). Of patients sustaining complications after primary TKA requiring return to the operating room, 10

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Table 1. Detailed analysis of complications and demographics and complication subdivided by obesity and nutritional status.

	Normal Nutritional Status			Malnourished		
	BMI > 40 (n = 101)	BMI < 40 (n = 486)	p value	BMI > 40 (n = 24)	BMI < 40 (n = 59)	p value
Age (years)	59.4	61.4	0.051	57.0	60.5	0.216
BMI (kg/m^2)	44.8	29.6	< 0.001	46.7	29.4	< 0.001
Length of Stay (days)	3.29	3.29	0.966	3.67	3.98	0.616
Serum Albumin (g/dL)	3.89	4.02	< 0.001	3.38	3.29	0.065
Hip Arthroplasty	19 (19)	190 (39)	< 0.001	4 (17)	23 (39)	0.070
COPD	3 (3)	21 (4)	0.782	0 (0)	6 (10)	0.175
CAD	7 (7)	40 (8)	0.661	4 (16)	6 (10)	0.465
CHF	3 (3)	9 (2)	0.443	4 (16)	6 (10)	0.465
Intraoperative Vasopressors	30 (30)	201 (41)	0.015	10 (42)	26 (44)	0.841
Chronic Kidney Disease	7 (7)	59 (12)	0.132	4 (17)	15 (25)	0.566
Diabetes	30 (30)	82 (17)	< 0.003	9 (38)	7 (12)	0.007
Any complication	7 (7)	40 (8)	0.661	7 (29)	15 (25)	0.726
ICU intervention	1 (1)	11 (2)	0.701	3 (13)	9 (15)	1.000
Return to OR	1 (1)	15 (3)	0.323	1 (4)	6 (10)	0.667
90 Day Readmission	5 (5)	19 (4)	0.585	5 (20)	9 (15)	0.533

Table 2. List of complications by nutritional status and obesity following primary total joint arthroplasty. Two patients had more than one complication during the study period.

	Normal Nutritional Status			Malnourished		
	BMI > 40 (n = 101)	BMI < 40 (n = 486)	p value	BMI > 40 (n = 24)	BMI < 40 (n = 59)	p value
Cardiac	1 (1)	6 (1.2)	1.000	1 (4)	5 (8)	0.667
Pulmonary	2 (2)	1 (0.2)	0.078	0 (0)	2 (3)	1.000
Gastrointestinal	1 (1)	1 (0.2)	0.315	2 (8)	1 (2)	0.199
Endocrine	0 (0)	0 (0)	1.000	1 (4)	0 (0)	0.289
Neurologic	0 (0)	2 (0.4)	1.000	1 (4)	0 (0)	0.289
Renal	1 (1)	5 (1)	1.000	1 (4)	1 (2)	0.497
Bleeding	2 (2)	5 (1)	0.346	0 (0)	1 (2)	1.000
Thromboembolic Event	1 (1)	3 (0.6)	0.531	0 (0)	0 (0)	1.000
Arthrofibrosis requiring MUA	0 (0)	9 (2)	0.370	0 (0)	1 (2)	1.000
Revision for instability	0 (0)	4 (0.8)	1.000	0 (0)	0 (0)	1.000
Periprosthetic fracture	0 (0)	2 (0.4)	1.000	0 (0)	1 (2)	1.000
Infection requiring return to OR	0 (0)	2 (0.4)	1.000	1 (4)	4 (7)	1.000

patients underwent manipulation under anesthesia and 4 patients underwent subsequent surgery for infection. Of the patients requiring surgical complications after THA, 3 patients sustained periprosthetic femur fracture, 3 patients required surgery for wound drainage or infection, and 4 patients required subsequent surgery for instability. Based on multivariate logistic regression analysis, malnutrition is an independent risk factor for complications following primary TJA (adjusted odds ratio 3.00, 95% CI 1.56 − 5.75). Our study did not detect a significant independent increase in complications in obese patients with BMI > 35, 40, 45, or 50 kg/m^2. Univariate and multivariate logistic regression analyses are detailed in table 3.

Table 3. Multivariate logistic regression analysis of comorbid risk factors for complications after primary TJA.

	Univariate Analysis			Multivariate Analysis		
Risk Factor	Unadjusted Odds Ratio	95% Confidence Interval	p value	Adjusted Odds Ratio	95% Confidence Interval	p value
Albumin < 3.5 g/dL	4.14	2.34 − 7.33	< 0.001	3.00	1.56 − 5.75	< 0.001
BMI > 50 kg/m2	1.09	0.25 − 4.85	0.908	2.39	0.28 − 20.41	0.424
BMI > 45 kg/m2	0.57	0.20 − 1.63	0.301	0.32	0.06 − 1.67	0.176
BMI > 40 kg/m2	1.12	0.60 − 2.09	0.713	1.82	0.70 − 4.71	0.216
BMI > 35 kg/m2	0.92	0.54 − 1.57	0.753	0.74	0.34 − 1.58	0.434
Age > 75 years	1.27	0.61 − 2.58	0.518	0.69	0.29 − 1.64	0.404
Hip Arthroplasty	1.13	0.67 − 1.88	0.652	0.97	0.52 − 1.80	0.932
COPD	2.84	1.17 − 6.87	0.021	2.35	0.85 − 6.48	0.097
CAD	2.94	1.49 − 5.78	0.002	1.15	0.46 − 2.91	0.765
CHF	2.92	1.84 − 4.00	0.002	5.50	1.85 − 16.39	0.002
Intraoperative Vasopressors	1.44	0.87 − 2.37	0.155	1.41	0.79 − 2.51	0.250
Chronic Kidney Disease	6.01	3.45 − 10.47	< 0.001	4.73	2.46 − 9.09	< 0.001
Diabetes	0.78	0.39 − 1.54	0.481	0.71	0.33 − 1.51	0.371

Discussion

Many surgeons consider both morbid obesity and malnutrition to be modifiable risk factors when selecting a patient for TJA. However, some factors may be more modifiable than others. Morbidly obese patients with debilitating osteoarthritis may find weight loss through exercise difficult, however nutrition can be modified with supplements prior to undergoing primary TJA. Our data demonstrating malnutrition as an independent risk factor for complications in joint replacement surgery is in agreement with several other published studies.[7,8,9] Obesity and morbid obesity has also been linked to short-term complications following TJA as well.[10,11,12] The link between malnutrition and obesity in TJA is not as clear, however. Our study sought to explain if short-term complications in morbidly obese primary total hip and knee arthroplasty patients are due to the patient's high BMI, low serum albumin, or both.

This study has several limitations including its retrospective design. Follow-up for our study was limited. While we can accurately report short-term complications, critical care intervention, and readmission rates, long-term complications such as revision arthroplasty for loosening, infection, and instability were not followed after 6 months. Our study was adequately powered to detect a difference in complications among all primary total joints patients, however it lacked adequate power to detect this difference between the subgroups of morbidly obese hip and knee patients. While morbid obesity in the absence of malnutrition may not increase in hospital complication or readmission rates, several studies have shown a negative effect of increased BMI on both infection and survivorship of total hip and knee arthroplasty.[13,14] Another limitation is our definition of malnutrition. Serum albumin has been validated as a marker for nutritional status in orthopaedic surgery patients, but the orthopaedic literature is lacking in defining a strict cutoff for malnutrition.[4,15] We used a threshold of 3.5 mg/dL to define malnutrition, which was used in several published studies.[3,15] Other nutritional markers such as transferring, prealbumin, and absolute neutrophil count were not measured in our study.

Although the complication rate, ICU rate, and 90-day readmission was higher for all malnourished patients, there was no difference in complications between malnourished morbidly obese patients and malnourished patients with BMI under 40 kg/m2 (29% vs. 25%, $p = 0.726$). Similarly, morbidly obese patients with normal nutritional status also had no difference in complications than non-morbidly obese patients with normal nutritional status (7% vs. 8%, $p = 0.661$). When controlling for other confounding variables with logistic regression, we did not find obesity or morbid obesity to be an independent risk factor in our series. Our data suggests that morbidly obese patients with normal serum albumin are at no greater risk for short-term complications, need for critical care, or 90-day admission rate. Preoperative screening with serum albumin, particularly in morbidly obese patients, can identify at-risk patients for complications. Further study is needed to determine if correcting malnutrition prior to surgery will improve outcomes following primary TJA.

References

1. Peersman, G, Laskin, R, Davis, J, et al. Infection in total knee replacement: A retrospective review of 6489 total knee replacements. *Clinical Orthopaedics and Related Research*, 392:15 (2001).

2. Jaberi, FM, Parvizi, J, Haytmanek, CT, et al. Procrastination of wound drainage and malnutrition affect the outcome of joint arthroplasty. *Clin Orthop Relat Res*, 466(6):1368 (2008).

3. Dreblow, DM, Anderson, CF ,Moxness, K. Nutritional assessment of orthopedic patients. *Mayo Clin Proc*, 56(1):51 (1981).

4. Greene, KA, Wilde, AH ,Stulberg, BN. Preoperative nutritional status of total joint patients. Relationship to postoperative wound complications. *J Arthroplasty*, 6(4):321 (1991).

5. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser*, 894:i (2000).

6. Sink, EL, Leunig, M, Zaltz, I, et al. Reliability of a complication classification system for orthopaedic surgery. *Clin Orthop Relat Res*, 470(8):2220

7. Cross, MB, Yi, PH, Thomas, CF, et al. Evaluation of malnutrition in orthopaedic surgery. *Journal of the American Academy of Orthopaedic Surgeons*, 22(3):193 (2014).

8. Savio, GCD, Zelicof, SB, Wexler, LM, et al. Preoperative nutritional status and outcome of elective total hip replacement. *Clinical Orthopaedics and Related Research*, 326:153 (1996).

9. Skaliczki, G, Schandl, K, Weszl, M, et al. Serum albumin enhances bone healing in a nonunion femoral defect model in rats: a computer tomography micromorphometry study. *International Orthopaedics*, 37(4):741 (2013).

10. Griffin, FM, Scuderi, GR, Insall, JN, et al. Total knee arthroplasty in patients who were obese with 10 years followup. *Clin Orthop Relat Res*(356):28 (1998).

11. Stern, SH ,Insall, JN. Total knee arthroplasty in obese patients. *J Bone Joint Surg Am*, 72(9):1400 (1990).

12. Yeung, E, Jackson, M, Sexton, S, et al. The effect of obesity on the outcome of hip and knee arthroplasty. *Int Orthop*, 35(6):929

13. Bourne, R, Mukhi, S, Zhu, N, et al. Role of obesity on the risk for total hip or knee arthroplasty. *Clin Orthop Relat Res*, 465:185 (2007).

14. Hamoui, N, Kantor, S, Vince, K, et al. Long-term outcome of total knee replacement: does obesity matter? *Obes Surg*, 16(1):35 (2006).

15. Gherini, S, Vaughn, BK, Lombardi, AV, Jr., et al. Delayed wound healing and nutritional deficiencies after total hip arthroplasty. *Clin Orthop Relat Res*(293):188 (1993).