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ORIGINAL RESEARCH

Preoperative Weight Loss in Morbidly Obese Patients Undergoing Total Joint Arthroplasty: A Cross-Sectional Analysis of a National Quality Database

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ABSTRACT

Background: Morbid obesity is a risk factor for complications following total joint arthroplasty, but the benefits of weight loss in mitigating adverse outcomes remain unclear.
Methods: The national quality database (NSQIP) was queried for all morbidly obese patients who underwent elective, primary unilateral total hip or knee arthroplasty (THA, TKA) between 2011–2018, and operative time, length of stay (LOS), discharge destination, 30-day complications, readmissions and reoperations assessed. Patient with ≥10% vs <10% body weight loss within 6 months before surgery were compared. These 2 groups (69 vs 207 patients) were matched by age, sex, BMI, ASA score, year of surgery, and THA or TKA procedure. Multivariate logistic regression was performed to determine the associations between weight loss and outcomes.
Results: Despite matching, patients in the weight loss group had higher prevalence of COPD (P=0.014), dyspnea (P=0.002), hypoalbuminemia (P=0.004), and dependent functional status (P<0.001). After controlling for those baseline differences, no significant changes were noted in any of the study outcomes, except for a trend toward shorter LOS following TKA in the weight loss group (P=0.084).
Conclusion: Contrary to expectations, this retrospective review of a national quality database suggests weight loss alone may not be an adequate strategy to mitigate the risks of morbid obesity.
Level of Evidence: III; Retrospective database review.
Keywords: Hip arthroplasty; Knee arthroplasty; Morbid obesity; Weight loss; Outcomes.

INTRODUCTION

The adult obesity epidemic in the United States is projected to continue worsening, reaching an estimated prevalence of 48.9% by 2030 [1]. For total joint arthroplasty (TJA), this projection is especially concerning as obesity has been shown to be an independent predictor of poor outcomes. In particular, morbid obesity—defined by a body mass index (BMI) greater than or equal to 40, was associated with increased rates of complications, readmissions and reoperations

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resulting in prolonged hospitalizations and higher costs of care [2–4]. Therefore, in an effort to mitigate the adverse outcomes of obesity, several practices have established BMI cutoffs for patients undergoing TJA, the most common of which being ≤40 [5,6].

Although it seems intuitive that weight loss in morbidly obese patients may be a logical solution to improve the outcomes of surgery, previous studies have produced mixed results [6,8–11,12]. In addition to questions about the validity of specific weight loss targets, the optimal weight loss method remains a topic of debate with studies in TJA cohorts reporting variable findings [6,10]. Furthermore, there remains no consensus on the optimal timing of weight loss prior to TJA with concerns regarding the risks associated with weight loss-induced catabolic state prior to surgery [13]. Given the difficulty that morbidly obese patients experience when attempting to drop sufficient weight to reach certain BMI cutoffs, it is imperative that the ability of preoperative weight loss to mitigate the risks associated with morbid obesity be established.

In this retrospective analysis of a national quality database, we asked a simple question: does weight loss within 6 months from primary TJA in morbidly obese patients improve perioperative outcomes? The answer to this question is critical to evaluate the efficacy of current risk stratification protocols.

METHODS

This study received exemption from our institutional review board. The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) was queried for all elective, primary, unilateral total hip and knee arthroplasties (THA, TKA) performed between 2011–2018 with BMI≥40. Patients with missing BMI and those undergoing non-elective or revision arthroplasties were excluded.

Demographic information collected from the database included patient age, sex, BMI, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and Asian). Comorbidities available in NSQIP were also collected for each patient. These included tobacco smoking within 1 year of surgery, chronic steroid use, diabetes mellitus (DM), hypertension (HTN), chronic obstructive pulmonary disease (COPD), dyspnea, bleeding disorders, anemia, and chronic kidney disease (CKD). Anemia was defined as hematocrit <42% in males or hematocrit <37% in females. CKD was defined as preoperative creatinine >1.5mg/dL [14,15]. Perioperative characteristics, including diagnosis (primary osteoarthritis vs all other), the American Society of Anesthesiologists (ASA) physical classification, and preoperative albumin were also collected.

Patients were sorted into two groups based on preoperative weight loss: those with BMI≥40 at admission and ≥10% weight loss within 6 months of surgery (experimental group) and a matched subset of patients with BMI≥40 at admission and <10% weight loss within 6 months of surgery (control group). The control group was generated by 3:1 propensity score matching that controlled for age, sex, BMI, ASA score, year of surgery, and procedure (THA or TKA). The study outcomes were differences in operative time (minutes), hospital length of stay (LOS) in days, discharge destination (home vs. facility), and 30-day adverse events (any medical or surgical complications, readmissions, reoperations, and mortality).

Categorical variables were reported as frequencies and compared using Pearson's Chi-squared test. Continuous variables were presented as mean with standard deviation and compared using Student's t-test. All reported *P*-values were 2-sided and *P*-values <0.05 were considered significant. Multivariate logistic regression produced odds ratios with 95% confidence intervals for primary outcomes by controlling for significant demographic, comorbidity, and perioperative variables. Continuous outcome variables (eg, LOS, operative time) were analyzed using multivariate linear regression and presented as regression coefficients with 95% confidence intervals. Data was analyzed using Stata® 16.1 software (Stata Corp, 204 College Station, TX).

Table 1. Patient Characteristics for Study Groups.

	BMI≥40 & <10% Weight Loss	BMI≥40 & ≥10% Weight Loss	*P*-Value
N (% of total)	207 (75%)	69 (25%)	—
Demographic Characteristics			
Age (years)	61.1±7.9	61.4±9.3	0.789
Sex (male: female)	80 (38.7%) & 127 (61.3%)	28 (40.6%) & 41 (59.4%)	0.776
BMI	45.4±6.6	45.1±4.4	0.699
Race/Ethnicity			
Non-Hispanic White	136 (65.7%)	58 (84.1%)	0.004**
Non-Hispanic Black	26 (12.6%)	3 (4.4%)	0.054
Hispanic	11 (5.3%)	2 (2.9%)	0.412
Asian	1 (0.5%)	0 (0%)	0.563
Comorbidities			
Smoker within 1 year	19 (9.2%)	6 (8.7%)	0.904
Chronic steroid use	11 (5.3%)	1 (1.45%)	0.173
Diabetes	51 (24.6%)	25 (36.2%)	0.062
Hypertension	152 (73.4%)	58 (84.1%)	0.073
COPD	6 (2.9%)	7 (10.1%)	0.014*
Bleeding Disorders	5 (2.4%)	5 (7.3%)	0.063
Anemia	59 (28.5%)	19 (27.5%)	0.877
Dyspnea	15 (7.3%)	14 (20.3%)	0.002**
Chronic kidney disease	5 (2.4%)	3 (4.4%)	0.407
Perioperative Characteristics			
Primary osteoarthritis	197 (95.2%)	62 (89.9%)	0.112
Total Hip Arthroplasty	59 (28.5%)	22 (31.9%)	0.593
Total Knee Arthroplasty	148 (71.5%)	47 (68.1%)	0.593
ASA Physical Classification	2.9±0.5	2.9±0.6	0.692
Preoperative Albumin (g/dL)	4.0±0.4	3.7±0.5	0.004**

ASA, American Society of Anesthesiologists; BMI, body mass index; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; OA, osteoarthritis; *P<0.05; **P<0.01.

RESULTS

The weight loss group had a higher percentage of non-Hispanic White patients (84.1% vs 65.7%, *P*=0.004), and were also more likely to have COPD (10.1% vs 2.9%, *P*=0.014), dyspnea (20.3% vs 7.3%, *P*=0.002), and lower albumin levels (3.7 vs 4.0, *P*=0.004). No other significant differences were noted between the two groups. Table 1 summarizes the baseline characteristics of the study cohorts.

Among patients undergoing THA, there were no significant differences in any of the primary outcomes evaluated after controlling for the significant baseline factors. There were also no significant differences between groups for TKA, except for a tendency towards shorter LOS in the weight loss group (*P*=0.084). These findings are summarized in Table 2.

DISCUSSION

Despite the negative outcomes associated with obesity in patients undergoing TJA, there remains no clear consensus on whether pre-operative weight loss can mitigate those outcomes. Using a retrospective analysis of a national quality database, this study found no significant differences in operatives times, LOS, discharge destination, or 30-day adverse events among morbidly obese patients who lost ≥10% weight in the six months prior to primary TJA compared to those without weight loss. There was only a trend toward shorter hospitalization following TKA in the weight loss group. In addition, morbidly obese patients with significant weight loss had higher prevalence of major comorbidities including hypoalbuminemia.

Several studies have evaluated the effects on weight reduction on TJA outcomes with mixed results suggesting that the weight loss is a complex process. In a retrospective review of 203 morbidly obese patients from a single institution, Keeney et al [6] found that those who lost at least 20 pounds prior to TKA experienced shorter LOS and lower odds of facility discharge. The same study found no difference in outcomes after 5 or 10 pound weight loss, nor a change in operative time or physical

Table 2. Results of the Multivariate Logistic Regression Analyses.

Outcome	BMI≥40 & Weight Loss ≥10% Within 6 Months Prior to Surgery (reference: <10% weight loss group)			
	Total Hip Arthroplasty		Total Knee Arthroplasty	
	Odds Ratio (95%CI)	*P*-Value	Odds Ratio (95%CI)	*P*-Value
Length of Stay >2 days	0.82 (0.18–3.65)	0.795	0.53 (0.16–1.73)	0.294
Discharge to Home	1.73 (0.35–8.47)	0.501	0.77 (0.21–2.82)	0.698
Any 30-day Complication	0.38 (0.04–3.96)	0.418	2.08 (0.15–28.24)	0.582
Any 30-day Reoperation	3.39 (0.14–82.40)	0.453	None Reported	—
Any 30-day Readmission	0.48 (0.04–5.28)	0.548	0.89 (0.03–24.08)	0.945
	Regression Coefficient		Regression Coefficient	
Length of Stay (days)	–0.63 (–1.61 to 0.36)	0.200	–0.68 (–1.44 to 0.09)	0.084
Operative Time (minutes)	19.06 (–5.58 to 43.70)	0.130	5.57 (–18.50 to 29.65)	0.650

function scores after any amount of weight loss. In another retrospective review of 14,784 patients from a single integrated healthcare system, Inacio et al [10] found no difference in superficial or deep SSI nor 90 day readmission rates among patients who lost 5% body weight without surgical intervention in the year preceding TJA.

The mixed results from past studies and lack of risk reduction in our study may indicate a multifactorial nature of weight loss. Although obesity is measured by BMI, other metrics may provide a more accurate preoperative risk stratification. For example, BMI may inadequately convey risks associated with TJA, whereas other means of measuring obesity may provide more accurate preoperative risk stratification. In a retrospective review of 316 patients undergoing primary TJA at a single medical center, Ledford et al [17] found that increased percent body fat (PBF) was associated with LOS greater than 3 days, increased post-operative transfusions, and higher chance of discharge to a facility while no significant difference existed when utilizing BMI. In another retrospective review of 58 matched patients, Watts et al [18] demonstrated increased risk of reoperation for wound complications or infections within 90 days in TKA patients with greater periarticular subcutaneous tissue despite similar BMI. The authors attributed this finding to increased dead space following closure, increased operative time, and underlying inflammatory state. Though BMI is the standard measure of obesity for most clinicians, BMI is unable to distinguish fat from muscle, and does not account for differing body habitus or fat distribution. Therefore, patient-specific measures may provide better perioperative prognostic value when available or may be worth pursuing. Our database study was limited to BMI as a measure of obesity, though based on studies described above, it is plausible that the use of other measures of obesity such as percent body fat or soft tissue envelope could have demonstrated a reduction in perioperative complications.

It stands to reason that patients who lose weight due to underlying pathologies would be sicker and have worse outcomes than patients who lose weight under physician supervision through diet or bariatric surgery. Two clinical trials investigating dietic weight loss showed no statistically significant changes in post-operative TJA outcomes were associated with weight loss, but both studies focused on functional outcomes 1 year after surgery and lacked statistical power [20,21]. Though studies investigating dietetic weight loss did not demonstrate changes in perioperative outcomes, a recent meta-analysis by Li et al [22] identified reductions in operative time, LOS, and short-term medical complications in patients undergoing bariatric surgery before TJA. Although this meta-analysis suggested that bariatric surgery conveyed significant benefits in terms of decreased short-term complications, it could not address questions regarding the timing or quantity of weight loss which are important factors.

Further evaluation is needed to clarify the optimal timing of weight loss, as previous studies have demonstrated improved outcomes when weight loss following bariatric surgery was achieved over a prolonged period of time [11,23]. Weight loss through diet, however, is confounded by various factors including the presence of medical comorbidities and difficulty of confirming diet adherence. Though our study was limited to patients with weight loss in 6 months before TJA, previous retrospective studies have reported improved outcomes when bariatric

surgery is completed at least 6 months before arthroplasty [11,23]. In one retrospective review of 1,347 patients from an integrated healthcare system, Schwarzkopf et al [23] reported a decreased likelihood of 90-day readmission in patients whose bariatric surgery was performed more than 6 months before THA. In another retrospective review of 11,032 patients from an integrated healthcare system, 171 of whom underwent bariatric surgery, Inacio et al [11] described fewer complications when bariatric surgery was performed greater than 2 years before TJA although the 90-day readmission rate was higher in the same group. The findings from bariatric surgery studies align with a separate systematic review of 43 studies by O'Brien et al [24] who demonstrated that maximum weight loss and metabolic equilibrium occurred two years following bariatric surgery. Separating bariatric surgery and arthroplasty by at least 6 months may also allow for the realization of increased benefits from weight loss and decreased risk of comorbidities. Though our study did not control for mechanism of weight loss, it stands to reason that such significant weight loss in only 6 months preceding TJA may not allow for correction of comorbidities or metabolic equilibrium and may leave the body in a catabolic state prior to surgery, which may also contribute to our lack of risk reduction.

Obesity is not only an independent risk factor for complications following TJA, but also a surrogate for other comorbidities which should be addressed prior to arthroplasty. Previous studies have shown comorbidities associated with obesity, including diabetes mellitus, cardiovascular disease malnutrition, and metabolic syndrome, to be risk factors for postoperative complications including wound complications and readmission [22,25]. Using serum albumin as a surrogate marker, previous studies, have not only identified malnutrition as a common comorbidity in both obese patients and those who undergo rapid weight loss, but also demonstrated its adverse effects on post-TJA outcomes [26–28]. A retrospective review of 49,603 patients using the NSQIP database by Bohl et al [27] demonstrated an independent association between hypoalbuminemia and increased risk of SSI, pneumonia, LOS, readmission, and overall number of complications following primary TJA.

Though not limited to obese patients, a recent prospective study of 4,733 patients within a small hospital network by Schroer et al [29] reported that addressing malnutrition via nutritional intervention shortened LOS, reduced readmission, and reduced associated costs. These findings suggest that simultaneously addressing comorbidities associated with obesity and weight loss is another opportunity to improve outcomes. Our analysis found a statistically significant lower albumin levels in the weight loss group, which may be a result of the catabolic state due to rapid weight loss. Given the lack of significant difference in outcomes after controlling for hypoalbuminemia, it is important to consider whether malnutrition may have negated any benefits of weight loss and that addressing weight loss without addressing concomitant comorbidities is short sighted.

This study has a few limitations. Similar to other large database studies, the validity of our analysis is dependent upon the participating institutions contributions. However, audits of the NSQIP database have demonstrated it to be a reliable source of information and it has been used in a myriad of studies. Second, we were limited to evaluating obesity using BMI only, rather than

other measures such as percent body fat or skin envelope which have been shown to accurately predict perioperative risk. Third, our study was retrospective in nature, limiting our ability to draw causative conclusions. Fourth, our study only evaluated complications in the 30-day postoperative period. Lastly, the mode of weight loss in our study group is unknown.

CONCLUSIONS

Despite the general recommendation of weight loss for obese patients undergoing primary TJA, our retrospective review did not reveal a significant reduction in perioperative complication rates in morbidly obese patients with >10% weight loss prior to surgery despite controlling for a wide number of comorbidities. This suggests rapid weight loss in the months immediately preceding arthroplasty may negate the benefits of weight reduction on postoperative outcomes in morbidly obese patients. Surgeons requesting weight loss should recognize that rapid, supratherapeutic weight loss can introduce complications, including hypoalbuminemia, which may increase both perioperative complications and costs associated with TJA. While there is still much to be studied regarding weight loss and arthroplasty, optimizing post-TJA outcomes in obese patients is much more nuanced than simple weight reduction.

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