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Underweight BMI Values and their Influence on Prosthetic Breast Reconstruction 30-Day Outcomes

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Abstract

Background: Risk factors for breast reconstruction have been widely studied. However, the impact of underweight BMI values on outcomes has not yet been examined.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was retrospectively reviewed for all patients who underwent prosthetic breast reconstruction between 2006 and 2011. Underweight (BMI<18.5) and normal weight (reference, BMI 18.5–24.99) patients were included in the final analysis. Multivariate logistic regression models were used to determine independent predictors of complications.

Results: The underweight and normal weight patient cohorts were well-matched. When compared to the normal weight population, underweight patients displayed decreased rates of total complications, surgical complications, and reoperation. On multivariate analysis, patients with a BMI in the underweight category trended toward lower risk for total and surgical complications. The sum of total relative value units (RVUs) was a significant risk factor for total complications (OR 1.014, p=0.047).

Conclusion: Through this analysis of over 1,600 patients, we reveal that underweight patients (BMI<18.5) receiving prosthetic breast reconstruction did not have any significant differences in adverse events than their normal weight counterparts. As more patients are collected in NSQIP, it will be possible to delineate between those with underweight due to lean body mass versus chronic diseases, allowing more granular analysis of the relationship between underweight status and outcomes after breast reconstruction.

Keywords: Prosthetic breast reconstruction; Underweight; Complications

Introduction

Obesity and elevated body mass index (BMI) have been a focus of contemporary medical research, largely due to their contributions to adverse medical outcomes [1]. Conversely, low BMI has recently been described as a risk factor for medical and surgical adverse events (AE) [2-4]. Several recent studies on critically and chronically ill patients suggest that underweight patients have an increased risk for death and catastrophic complications [5-11]. However, low BMI may be a result of physical fitness, as opposed to chronic illness. Recent literature has detailed an association between obesity and poor surgical outcomes in the breast reconstruction population [12-19]. In contrast, very little has been written about the risk of underweight patients undergoing breast reconstruction surgery. Studies attempting to do so have been compromised by small sample sizes, single-institutional bias and inconsistent definitions of underweight [20-22].

In an effort to better understand the influence of underweight BMI on outcomes following breast reconstruction, we examined the National Surgical Quality Improvement Program (NSQIP) datasets. We aimed to define and benchmark the risks and outcomes following prosthetic breast reconstruction – the most popular reconstruction method globally – utilizing a detailed analysis of underweight patients.

Methods

Data source

The information incorporated into the NSQIP database is extracted from patient medical records, physician office records, and telephone interviews by trained surgical clinical nurse reviewers (SCNRs). Intensive training sessions for the nurse reviewers have helped ensure the reliability of the data, as studies have revealed a low rate (1.96%) of inter-observer disagreement across variables [23]. All information is subsequently de-identified and is made freely available to all institutional members who comply with the NSQIP Data Use Agreement.

Patient population

All patients with 'Plastics' recorded as their primary surgical team was isolated from the 2006-2011 NSQIP databases. Prosthetic breast reconstruction patients were subsequently identified by standardized procedural description codes – a variable tracked in the database (i.e., CPT code 19357). Those who underwent multiple types of breast reconstruction were excluded. Patients with an underweight BMI, defined as BMI<18.5, or a normal range BMI (18.5-24.99) were included in the final analysis.

Outcomes

Our primary outcomes of interest were: 30-day surgical

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complications, medical complications, reoperation, and mortality. Surgical complications were defined as having ≥ 1 of the following ACS-NSQIP post-operative adverse events: superficial surgical site infection (SSI), deep SSI, organ/space SSI, wound disruption/ dehiscence, or graft/prosthesis failure. Medical complications included: pneumonia, unplanned intubation, pulmonary embolism, failure to wean from ventilator, renal insufficiency, progressive renal failure, urinary tract infection, stroke, coma, peripheral neurologic deficiency, cardiac arrest, myocardial infarction, bleeding requiring a transfusion, deep venous thrombosis (DVT), and sepsis/septic shock. Reoperation was defined as any unplanned return to the operating room for surgical intervention within 30 days. Mortality was defined as death within 30 days of the index procedure.

Statistical Analysis

Prosthetic reconstruction patients were stratified into underweight and normal weight (reference) BMI categories. Patient demographics and clinical characteristics – including diabetes, hypertension, chemotherapy within 30 days, radiation within 90 days, and chronic steroid or immunosuppression use – were tracked as potential confounders. Alcohol use and smoking were also tracked as behavioral risk factors. Albumin levels were only rarely available, and therefore were not included for analysis. Chi-square analysis was used to compare categorical variables and independent T-tests were used to analyze continuous variables. Multivariable logistic regression analysis was utilized to investigate the impact of low BMI values on outcomes. Pre-operative variables with ≥ 10 occurrences and P ≤ .20 on bivariate screening were included in the analysis. All analyses were conducted using SPSS version 21 (Chicago, IL).

Results

After review of the 25,346 plastic surgery patients extracted from the NSQIP database, we found 3,513 patients who received prosthetic reconstruction. Of these, 1,652 were included for analysis based on BMI criteria. Seventy-seven of included patients were underweight (i.e., BMI<18.5), and the remaining 1,575 were normal weight (BMI 18.5-24.99). The average age of underweight patients undergoing prosthetic breast reconstruction was 51.1 years, compared to 50.0 years in the reference cohort (p=0.431, Table 1). Hypertension was the most common comorbidity in tracked patients, and smoking was the most common high-risk characteristic. Following stratification of the population into BMI categories, we observed that rates of chronic obstructive pulmonary disease (COPD), dyspnea, active smoking, and alcohol use were all elevated in the underweight cohort, but none of these factors reached significance (p>0.05). In addition, underweight patients had slightly higher relative value unit (RVU) totals and operative times (p>0.05).

Total complications, surgical complications, and reoperation rates were all higher in the reference group compared to the underweight population–but these differences were not statistically significant (all p>0.05, Table 2). Specifically, total complications rose from 1.30% in underweight patients to 2.79% in normal weight patients (p= 0.720). Similarly, surgical complications rose from 1.30% to 1.78% (p=1.00) and reoperation rates increased from 0% to 3.05% (p=0.167). Only medical complications (1.30% vs 0.51%, p=0.350) and organ/ space SSI rates (1.30% vs 0.38%, p=0.284) were increased in the underweight population.

Multivariate regression analysis examined low BMI as a predictor of outcomes (Table 3). Our results showed that underweight status was not a risk factor for total complications, or surgical complications (p=0.440 and 0.536, respectively). The total RVU value – often used as a proxy for surgical complexity – carried a significant increased risk for total complications (OR 1.01 per additional RVU, 95% CI 1.00 – 1.03, p=0.047).

Discussion

This study defines and benchmarks the 30-day risks and outcomes after prosthetic breast reconstruction in underweight patients. By drawing data from a large, prospective cohort identified within the 2006-2011 NSQIP datasets, we endeavored to examine the impact of underweight BMI on prosthetic breast reconstruction outcomes in a manner representative of the national population. While surgical outcomes have been well documented in obese patients, this work represents the first population-based assessment of the impact of underweight BMI values (BMI < 18.5) on 30-day outcomes following prosthetic breast reconstruction [15-17].

We found a total of 3,513 patients who underwent prosthetic

	Underweight		Normal Weight		p-values
	<18.5		18.5-24.99		
	n = 77		n =1575		
	n	%	n	%	
Age	51.08 ± 11.99		50.04 ± 11.26		0.431
Hypertension	6	7.79%	204	12.95%	0.184
Diabetes	1	1.30%	26	1.65%	1.000
COPD	1	1.30%	11	0.70%	0.437
Dyspnea	2	2.60%	27	1.71%	0.395
History of TIA or CVA	0	0.00%	7	0.44%	1.000
Prior PCI or PCS	0	0.00%	16	1.02%	1.000
Active Smoking	13	16.88%	219	13.90%	0.371
Alcohol Use	2	2.60%	15	0.95%	0.186
Chronic Steroid Use	0	0.00%	15	0.95%	1.000
Wound Infection within 30 days	1	1.30%	30	1.90%	1.000
Outpatient cases	54	70.13%	1174	74.54%	0.387
Sum of Relative Value Units	34.30 ± 17.90		33.54 ± 19.33		0.735
Operative time (hours)	2.27 ± 2.18		2.10 ± 1.27		0.272
* denotes significant value, p<.05					

* denotes significant value, p<.05

Table 1: Prosthetic breast reconstruction patient clinical characteristics, stratified by BMI. (Independent T-test used for univariate statistical evaluation; significance set at p<0.05.

	Underweight	Normal Weight	
	<18.5	18.5-24.99	
	n = 77	n = 1575	
	%	%	
Total Complications	1.30%	2.79%	0.720
Surgical Complications	1.30%	1.78%	1.000
Wound Infection	1.30%	1.90%	1.000
Superficial SSI	0.00%	0.89%	1.000
Deep SSI	0.00%	0.63%	1.000
Organ/Space SSI	1.30%	0.38%	0.284
Dehiscence	0.00%	0.57%	1.000
Prosthesis Failure	0.00%	0.13%	1.000
Medical Complications	1.30%	0.51%	0.350
Reoperation	0.00%	3.05%	0.167
Death	0.00%	0.00%	-

Table 2: Post-operative complications following prosthetic breast reconstruction, stratified by BMI. (Independent T-test used for univariate statistical evaluation; significance set at p<0.05.

Variable	Total Complications				Surgical Complications			
	OR	95%	CI	p-value	OR	95%	CI	*p*-value
BMI category Underweight (BMI <18.5)	0.456	0.062	3.356	0.440	0.532	0.072	3.928	0.536
Normal weight (BMI 18.5-24.99)	reference				reference			
Sum of Relative Value Units (RVU)	1.014	1.000	1.028	0.047*	-	-	-	-

* Denotes significant value, p <0.05

Table 3: Multivariate Regression Analysis.

breast reconstruction during the study period. BMI stratification of this population revealed that 2.2% were underweight (BMI<18.5) and 44.8% were normal weight (BMI 18.5-24.99). Underweight patients were nearly the same age as the normal weight (reference) population and also displayed a lower incidence of preoperative comorbidities, with the exception of COPD, dyspnea, active smoking, and alcohol use. There was also a slight decrease in the number of outpatient cases and a slight increase in RVUs and operative time in the underweight cohort, although these differences were not significant [24-28].

While considerable attention has been focused on high BMI and breast reconstruction – with obese patients displaying increased rates of total complications – outcomes in underweight patients have been infrequently studied [20-22,29-31]. Our study suggests that patients with underweight BMI values do not have different rates of complications after implant-based breast reconstruction, compared to their normal-weight counterparts. We revealed that underweight patients displayed lower (but non-significant) rates of adverse events – except for organ/space SSI and medical complications – when compared to normal weight patients. This finding is in contrast with many recent studies in other surgical fields, which found a paradoxical relationship between BMI and postoperative mortality – with underweight patients displaying higher mortality rates than obese individuals after both cardiac and non-cardiac surgery [3,4,32-40]. Multivariate logistic regression further showed that an underweight BMI was not an independent predictor of total or surgical complications. Our only finding of significance was between increased RVU totals and total complications. This is not surprising as RVU values are often representative of greater surgical complexity, and technically difficult procedures may have an inherently higher risk for complications. Of note, the underweight cohort displayed a greater sum of RVUs, on average, compared to the normal weight population. This may reflect an increased degree of surgical complexity in these patients, including the need for ADM utilization, serratus muscle flap coverage, and other procedures to obtain total implant coverage. A smaller proportion of outpatient cases and greater average operative times in the underweight population substantiate this explanation.

There are a number of factors confounding an investigation into low BMI and outcomes [30]. Certain findings suggest that the association between a low BMI and increased mortality is in part an artifact of preexisting disease. First, the association between underweight BMI and increased mortality has been found in previous studies to be substantially weaker after 15 years of follow-up (hazard ratio, 1.21) than after 5 years of follow- up (hazard ratio, 1.73) [30]. This finding is thought to correlate with greater confounding by other prevalent diseases that were either undiagnosed or not accounted for in the early years of follow-up. Specifically, chronic conditions that cause weight loss – namely cancer and respiratory and cardiac diseases – may remain unnoticed for months or even years; all of which could impact outcomes. It is also difficult for a large database to differentiate between persons with low BMI values who are physically active (i.e., those who were lean and fit) and persons with low BMI values who are inactive (i.e., those with illness-induced wasting). In our cohort, albumin levels were too infrequently collected to be statistically evaluated. While our study is the largest such evaluation of underweight breast reconstruction patients, it is still too small to subdivide the cohort into patients who were underweight secondary to physical fitness versus chronic disease. As the dataset continues to collect patients, it may be ultimately possible to delineate these populations. It has been observed elsewhere that low BMI may reflect an aging population, with an increased incidence of low muscle mass and increased rates of comorbid disease [41]. However, in our database, underweight patients were not significantly older, and had fewer comorbid diseases than normal weight patients. In fact, the infrequent presence of comorbid disease in this population may have contributed to the lower morbidity rates in the cohort.

One important difference between our underweight cohort and the reference population was the incidence of active smoking (16.9% vs 13.9%, p=0.371). Active smoking is another potential confounding factor as it is associated with a decreased weight, and is also a well-established risk factor for surgical complications [30,31,42]. Interestingly smoking was not determined to be a potential risk factor for total or surgical complications on bivariate screening. Ultimately underweight patients – even with a higher percentage of active smokers – had lower (but non-significant) rates of surgical complications (OR 0.53, p=0.54).

Although the ACS-NSQIP provides a useful database to conduct large observational studies, it has several limitations. First, the nature of the database limits the specific risk factors that can be evaluated to those that have been reported. For example, surgical details are underreported. Specifically, the database lacks information regarding mastectomy techniques (skin-sparing versus nipple-areola sparing) and fat transfer use. While timing of the procedure (i.e., immediate versus delayed) is known, we could not adequately investigate the impact of breast reconstruction timing due to limited patient population size. Patient factors that could impact outcomes, but are not reported in the database, include previous surgical procedures, degree of mammary ptosis, and breast size. Additionally, the duration of postoperative drains has been shown to be a significant risk factor for SSI in breast surgeries, but it is a variable that is not collected by the NSQIP database [43]. Several other common procedure-specific complications including hematoma, seroma, and fat necrosis are not captured in the datasets. Furthermore, the database does not include information on previous breast conservation therapy failure, disease stage, tumor burden, or postoperative radiation therapy – all of which may play a role in the development of complications. Finally, the database is limited to 30-day outcomes, thereby reducing our ability to evaluate longer term outcomes, including long-term aesthetic results. Underweight patients could have a greater number of long term complications from thinner skin coverage over implants – including capsular contracture, the need for reoperation, and even reconstructive failure, which would not be captured in a 30-day postoperative window. We acknowledge that additional breast reconstruction procedures may

have been coded under other surgical specialties; our decision to isolate cases performed only by 'Plastics' as the primary service likely limited our patient sample size. However, we chose this method to provide data unadulterated by additional surgical specialties, as any findings would then be directly attributed to board-certified plastic surgeons. Even with these fastidious patient selection criteria, the robust, multi-institutional nature of the NSQIP database offers a unique platform to conduct large scale analyses. Specifically, we were able to isolate over 1,600 patients undergoing prosthetic breast reconstruction to examine the heretofore undefined relationship between underweight status and postoperative outcomes.

Regardless of these limitations, our study has numerous implications for research, medical practice, and society. Patients, surgeons, and insurance payers must be aware that underweight status alone does not appear to confer an increased risk for adverse events after prosthetic breast reconstruction. It does confer a slightly increased use of surgical services and hospital length of stay, although these differences are not significant. Future research should be spent refining the NSQIP database to discern between patients who are underweight secondary to physical fitness, versus chronic disease, and in explaining the above-mentioned differences in resource utilization in the underweight population.

Conclusion

This study represents the only review to date of post-mastectomy prosthetic breast reconstruction in underweight patients. We reveal that, compared to normal weight patients, underweight patients undergoing prosthetic breast reconstruction have equivalent 30-day adverse events profiles. These data provide important information to patients, surgeons, and insurance payers for informed consent and risk stratification. As the NSQIP database evolves, it will possibly allow further delineation of underweight patients into lean/fit patients versus those suffering from chronic diseases.

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Conflict of Interest Statement

The authors have no financial disclosures relevant to this paper.

Ethical Approval

This study did not undergo Institutional Review Board approval as it is a retrospective review of data that was de-identified prior to distribution to participating institutions. De-identified patient information is freely available to all institutional members who comply with the ACS-NSQIP Data Use Agreement. The Data Use Agreement implements the protections afforded by the Health Insurance Portability and Accountability Act of 1996 and the ACS-NSQIP Hospital Participation Agreement.

Disclaimer

The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

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