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The Impact of Body Mass Index on Reduction Mammaplasty: A Multicenter Analysis of 2492 Patients

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Abstract

Background: Reduction mammaplasty is commonly performed in women who are considered obese by the body mass index (BMI) classification of the World Health Organization.

Objectives: The authors compare complication rates among breast reduction patients, stratified by BMI, across multiple institutions.

Methods: A retrospective analysis was performed of all reduction mammaplasties in the database of the National Surgical Quality Improvement Program for 2006 through 2010. Demographic, comorbidity, and BMI data were collected. Data on medical and surgical complications, reoperation, and mortality were collected through 30 days postsurgery.

Results: Of 2492 patients, 55% were considered obese (BMI >30). The overall rate of surgical complications was 4.0%, increasing from 2.4% for BMI <25 to 7.1% for BMI >45 ($P = .006$), with an adjusted odds ratio of 2.97 for BMI >45 versus BMI <25. The most common surgical complication was superficial surgical site infection; it was found in 2.9% of patients, increasing from 2.1% for BMI <25 to 5.1% for BMI >45 ($P = .03$). The medical complication rate was 0.6%, and the reoperation rate was 2.1%. There were no deaths. A maximal point analysis showed that BMI ≥39 was associated with a significantly higher complication rate, with an odds ratio of 2.38.

Conclusions: Reduction mammaplasty is a safe surgical procedure, even when performed on obese patients. However, patients with higher BMI have a greater risk of surgical site complications. This risk should be discussed preoperatively with obese patients.

Level of Evidence: 3

Keywords

breast surgery, breast reduction, reduction mammaplasty, body mass index, obesity, complications, National Surgical Quality Improvement Program

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According to the American Society for Aesthetic Plastic Surgery, nearly 113 000 breast reduction surgeries were performed in the United States in 2011, and reduction mammaplasty was the eighth most common plastic surgery procedure performed in the United States (when compared with aesthetic surgery procedures only).[1] The high prevalence of reduction mammaplasty underscores the fact that nonsurgical interventions have not been shown to provide lasting relief of symptomatic macromastia.[2] In addition, numerous studies have demonstrated increased patient satisfaction and better quality of life following reduction mammaplasty.[3-8] Such studies also demonstrate the importance of reduction mammaplasty as a therapeutic option, not just a cosmetic one.

Although some insurers will cover the cost of breast reduction surgery, the stipulations can be substantial. Many physicians and insurers require that women be at or near their ideal body mass index (BMI) or have participated in a trial period of physical therapy and exercise.[2,9,10] However, more than 34% of adults in the United States are

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considered obese,[11] and the mean BMI in recent studies of breast reduction surgery was 31[10] and 34.[12] The restrictions imposed by providers and insurers can be particularly problematic for obese women because their macromastia has already caused pain and discomfort, which may be exacerbated by exercise. On the other hand, some studies have shown that after reduction mammaplasty, women have greater ability to exercise and lose weight.[13-16]

Evidence of the effect of BMI on breast reduction complications is inconclusive. Several studies have demonstrated a positive correlation between increased BMI and the risk of complications,[10,17,18] but others have shown no difference in complication rates between ideal-weight and obese patients.[12,19,20] To investigate the impact of BMI on reduction mammaplasty for a generalized patient population, we utilized the database of the National Surgical Quality Improvement Program (NSQIP) of the American College of Surgeons (ACS).

The NSQIP database is a collection of data on surgical patients, reported randomly from participating hospitals, regardless of insurance status. Between 2006 and 2010, the database captured more than 1.3 million surgical procedures from more than 240 academic and community hospitals. The recorded data include 30-day outcomes and 135 independent variables describing patient demographics, comorbidities, and preoperative conditions. Defined outcomes—including postoperative morbidity, reoperations, and mortality—were tracked by specially trained nurses via chart review, supplemented where necessary with letters and phone calls to patients, and subjected to internal audit.[21] Because the database provides thorough data collection and reporting procedures for a broad patient population, it serves as a powerful tool to examine the impact of BMI on complication rates associated with reduction mammaplasty.

The present analysis of 2492 patients who underwent reduction mammaplasty between 2006 and 2010 represents the largest multi-institutional study to date of the impact of BMI on complication rates of breast reduction surgery. The study provides generalizable information for use in patient education and clinical decision making.

METHODS

The NSQIP data collection procedures have been described previously.[21] Reduction mammaplasty procedures performed in women from 2006 through 2010 were identified based on the primary *Current Procedural Terminology* code 19318 (reduction mammaplasty). Excluded from the study were men, patients who underwent multiple procedures, and patients for whom BMI data were lacking.

Outcomes of interest included postoperative morbidity, reoperation, and mortality. Morbidities tracked by the NSQIP were classified as medical or surgical. Surgical complications included superficial surgical site infection (SSI), deep SSI, nipple or flap necrosis (graft/prosthesis/flap failure), and wound disruption, which are defined in Table 1. Medical complications included pneumonia, unplanned intubation, ventilator dependence >48 hours, renal insufficiency, acute renal failure, urinary tract infection, coma, stroke, peripheral neurologic deficit, cardiac arrest, myocardial infarction, bleeding requiring a transfusion, deep venous thrombosis, sepsis, and septic shock. Complications, reoperation, and mortality rates were tracked for each patient through 30 postoperative days.

The patients were categorized into 1 of 6 BMI groups, based on the World Health Organization (WHO) classifications: BMI ≤24.9, normal weight; BMI 25.0 to 29.9, overweight; BMI 30.0 to 34.9, class 1 obesity; BMI 35.0 to 39.9, class 2 obesity (severe obesity in surgical literature); BMI 40.0 to 44.9, class 3 obesity (morbid obesity in surgical literature); and BMI ≥45.0, class 3 obesity (super obesity in surgical literature).[22-24] Class 3 obese patients were subclassified as "morbid" or "super obese" based on trends used in the surgical literature.

Statistical Analysis

Demographic and preoperative statistics were tabulated for all BMI categories and compared between groups with χ^2 or analysis of variance (ANOVA) testing for dichotomous and continuous variables, respectively. Complications, reoperations, and mortality rates also were tabulated and compared among the groups using χ^2 or Fisher exact tests. Two-tailed P values below .05 were considered significant. Multiple logistic regression analysis was performed to compare complication rates across BMI categories with correction for confounders. Variables describing preoperative patient status, comorbidities, and patient demographics were scanned for association with outcomes. All variables with at least 10 events and significance of $P < .2$ were included in the final regression models.[25-27] All odds ratios associated with BMI were measured with respect to the normal weight category (BMI <25), and therefore, by definition, the odds ratio for BMI <25 was 1. Complication profiles across BMI groups were scanned for a monotonic relationship, and the maximal statistic approach was used to assay for a cutoff point above which complications increase significantly.[28] All analyses were performed with SPSS version 20.0 (SPSS, Inc, an IBM Company, Chicago, Illinois).

RESULTS

A total of 2492 female breast reduction patients were identified and then categorized into 1 of the 6 groups (as described above), based on 5-point BMI intervals ranging from ≤24.9 to ≥45. Patient demographics and rates of hypertension, chronic obstructive pulmonary disease (COPD), diabetes, and smoking are listed in Table 2.

The mean (SD) age of the study population was 42.2 (14) years, and there was no statistically significant correlation between age and BMI ($P = .77$). The mean (SD) BMI was 31.7 (6.8). The rate of hypertension was 22.8%, which increased from 8.9% for BMI <25 to 45.5% for

Table 1. Surgical Outcome Variables as Defined by the National Surgical Quality Improvement Program

Superficial SSI	Superficial incisional SSI is an infection that occurs within 30 days after the operation; the infection involves only skin or subcutaneous tissue of the incision and at least 1 of the following: • Purulent drainage, with or without laboratory confirmation, from the superficial incision • Organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision • At least 1 of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat *AND* deliberate opening of a superficial incision by the surgeon (unless the incision site culture is negative) • Diagnosis of superficial incisional SSI by the surgeon or attending physician The following conditions are not considered SSI: Stitch abscess (minimal inflammation and discharge confined to the points of suture penetration) Infected burn wound Incisional SSI that extends into the fascial and muscle layers (*see* deep SSI)
Deep SSI	Deep incisional SSI is an infection that occurs within 30 days after the operation, appears related to the operation, and involves deep soft tissues (eg, fascial and muscle layers) of the incision area and at least 1 of the following: • Purulent drainage from the deep incision but not from the organ/space component of the surgical site • Spontaneous disruption of a deep incision or deliberate opening by a surgeon when the patient has at least 1 of the following signs or symptoms: fever (>38°C), localized pain, or tenderness (unless the incision site culture is negative) • An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination • Diagnosis of a deep incisional SSI by a surgeon or attending physician • (Note: For the analysis, infection that involves both superficial and deep incisional sites is reported as deep incisional SSI. An organ/space SSI that drains through the incision is reported as a deep incisional SSI.)
Organ/space SSI[a]	Organ/space SSI is an infection that occurs within 30 days after the operation, appears to be related to the operation, and involves any part of the anatomy (eg, organs or spaces), other than the incision site, that was opened or manipulated during the operation, and at least 1 of the following: • Purulent drainage from a drain that is placed through a stab wound into the organ/space • Organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space • An abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathologic or radiologic examination • Diagnosis of an organ/space SSI by a surgeon or attending physician
Nipple or flap necrosis (graft/flap failure)	Mechanical failure of an extracardiac graft or prosthesis, including myocutaneous flaps and skin grafts, that requires return to the operating room, interventional radiology, or a balloon angioplasty within 30 days of the operation
Wound disruption	Separation of the layers of a surgical wound, which may be partial or complete, with disruption of the fascia, within 30 days of the operation

SSI, surgical site infection.

[a]Due to the very small number of organ/space infections and the fact that deep infections and organ/space infections are very similar in the breast, organ/space infections were grouped with deep surgical site infections for the analysis.

BMI >45 (P < .001). The percentage of patients with diabetes mellitus was 4.5%. The rate of diabetes increased with BMI, from 0.6% for BMI <25 to 11.1% for BMI >45 (P < .001). The percentage of patients with COPD was 0.7%, and there were no significant differences among BMI categories. The percentage of smokers was 12.0%, and the rates according to BMI category (from lowest to highest BMI) were 9.2%, 9.4%, 15.2%, 15.1%, 10.2%, and 10.1% (P = .003) (Table 2).

The rates of surgical and medical complications, including reoperation, are shown in Table 3. The percentage of patients who experienced a complication increased steadily across BMI categories, with the greatest incidence at BMI >40. The overall rate of surgical complications was 4.0%, ranging from 2.4% for BMI <25 to 7.1% for BMI >45 (P = .006). Superficial SSI, the most common surgical complication, was found in 2.9% of patients; the rate increased from 2.1% for BMI <25 to 5.1% for BMI >45 (P = .03). Only 0.3% of patients had a deep SSI, and there was no correlation with any BMI category. Nipple or flap necrosis occurred in only 3 patients (0.1%); 2 of them had BMI of 30 to 35, and 1 had BMI >45. Wound disruption occurred in 23 patients (0.9%). Although a trend was observed between increasing wound disruption and increasing BMI, it was not statistically significant (P = .12). The average reoperation rate was 2.1%, with no statistically significant differences among BMI groups (P = .33).

Although surgical complication rates were higher among the obese cohort, medical complication rates did not differ significantly among the groups, either in aggregate (P = .17) or for any individual complication (P > .05 for each category). The total incidence of medical complications was low (0.6%). There were no instances of pneumonia, pulmonary embolism, ventilator dependence >48 hours, chronic renal insufficiency, acute renal failure, coma, stroke, peripheral neurologic deficit, or cardiac arrest. There were no deaths.

Regression analysis showed that, after controlling for confounders, patients in every BMI group had a progressively greater risk of complications as BMI increased (Table 4). However, this increase was only statistically

Table 2. Characteristics of the Study Population According to BMI Category

Characteristic	Overall (N = 2492)	BMI <25 (n = 336)	25 ≤ BMI <30 (n = 773)	30 ≤ BMI <35 (n = 726)	35 ≤ BMI <40 (n = 392)	40 ≤ BMI <45 (n = 166)	BMI ≥45 (n = 99)	*P* Value
Age, mean (SD), y	42.2 (14)	41.4 (15)	42.4 (15)	42.1 (14)	42.5 (13)	43.0 (13)	41.2 (12)	.77
BMI, mean (SD)	31.7 (6.8)	23.0 (2.0)	27.6 (1.4)	32.3 (1.4)	37.1 (1.4)	42.1 (1.4)	50.9 (5.7)	<.001
Hypertension, %	22.8	8.9	15.8	24.5	31.6	41.6	45.5	<.001
COPD, %	0.7	0.3	0.4	0.6	1.3	2.4	1.0	.06
Diabetes, %	4.5	0.6	2.1	4.7	5.6	15.7	11.1	<.001
Smokers, %	12.0	9.2	9.4	15.2	15.1	10.2	10.1	.003

Continuous variables are expressed as averages with standard deviations. Dichotomous variables are expressed as percentages. BMI, body mass index; COPD, chronic obstructive pulmonary disease.

Table 3. Complications According to BMI Category

Complication	Overall (N = 2492)	BMI <25 (n = 336)	25 ≤ BMI <30 (n = 773)	30 ≤ BMI <35 (n = 726)	35 ≤ BMI <40 (n = 392)	40 ≤ BMI <45 (n = 166)	BMI ≥45 (n = 99)	*P* Value
Any complication	112 (4.5)	9 (2.7)	27 (3.5)	33 (4.6)	20 (5.1)	14 (8.4)	9 (9.1)	.008[a]
Surgical complication	99 (4.0)	8 (2.4)	22 (2.9)	31 (4.3)	17 (4.3)	14 (8.4)	7 (7.1)	.006[a]
Wound infection	78 (3.1)	7 (2.1)	18 (2.3)	25 (3.4)	12 (3.1)	11 (6.6)	5 (5.1)	.05
Superficial SSI	72 (2.9)	7 (2.1)	17 (2.2)	23 (3.2)	9 (2.3)	11 (6.6)	5 (5.1)	.03[a]
Deep SSI	7 (0.3)	0	1 (0.1)	3 (0.4)	3 (0.8)	0	0	.30
Nipple or flap necrosis (graft/flap failure)	3 (0.1)	0	0	2 (0.3)	0	0	1 (1.0)	.08
Wound disruption	23 (0.9)	1 (0.3)	4 (0.5)	7 (1.0)	5 (1.3)	4 (2.4)	2 (2.0)	.12
Medical complication	14 (0.6)	1 (0.3)	5 (0.7)	2 (0.3)	4 (1.0)	0	2 (2.0)	.17
Unplanned intubation	1 (0.04)	0	1 (0.1)	0	0	0	0	.82
Urinary tract infection	4 (0.2)	0	2 (0.3)	0	1 (0.3)	0	1 (1.0)	.21
Myocardial infarction	1 (0.04)	0	1 (0.1)	0	0	0	0	.82
Blood transfusion	5 (0.2)	1 (0.3)	0	2 (0.3)	1 (0.3)	0	1 (1.0)	.35
Deep vein thrombosis	1 (0.04)	0	0	0	1 (0.3)	0	0	.37
Sepsis or septic shock	2 (0.1)	0	1 (0.1)	0	1 (0.3)	0	0	.73
Reoperation	52 (2.1)	5 (1.5)	17 (2.2)	10 (1.4)	11 (2.8)	6 (3.6)	3 (3.0)	.33

Values are presented as number (%). The following complications were not observed: pneumonia, pulmonary embolism, ventilator dependence >48 hours, chronic renal insufficiency, acute renal failure, coma, stroke, peripheral neurologic deficit, cardiac arrest, or death. BMI, body mass index; SSI, surgical site infection.
[a]Statistically significant across BMI categories.

significant for the 2 highest BMI categories ($P = .02$ for $40 \leq$ BMI < 45 and $P = .03$ for BMI ≥45). Hypertension (odds ratio [OR], 1.32; 95% confidence interval [CI], 0.87-2.03) and longer operating time (OR, 1.003; 95% CI. 1.000-1.005) were associated with a greater risk of complications, and performance of the procedure in an outpatient setting (OR, 0.80; 95% CI, 0.50-1.28) was associated with a lower risk. However, none of these factors was statistically significant ($P > .05$).

After a graphical analysis confirmed a monotonic relationship (Figure 1), maximal point analysis showed that BMI 39 provides the best differentiation point between higher and lower risk groups ($P < .001$). The odds ratio for complications among patients with BMI ≥39 versus those with BMI < 39 was 2.38. This further supports the finding that the 2 highest BMI categories are the only ones that showed a statistically significant difference in risk from baseline.

Table 4. Multivariate Regression Analysis: Total Complications According to BMI Category

Characteristic	Overall Complications			
	Odds Ratio	95% CI		*P* Value
Preoperative variable		Lower	Upper	
Outpatient procedure	0.80	0.51	1.28	.36
Hypertension	1.33	0.87	2.03	.20
Operating time	1.00	1.00	1.01	.07
Obesity				
BMI <25				.08
25 ≤ BMI <30	1.26	0.59	2.72	.55
30 ≤ BMI <35	1.58	0.74	3.35	.24
35 ≤ BMI <40	1.69	0.75	3.81	.20
40 ≤ BMI <45[a]	2.81	1.17	6.77	.02
BMI ≥45[a]	2.97	1.12	7.86	.03

BMI, body mass index; CI, confidence interval.
[a]These BMI categories were independently associated with a significantly greater risk of complications.

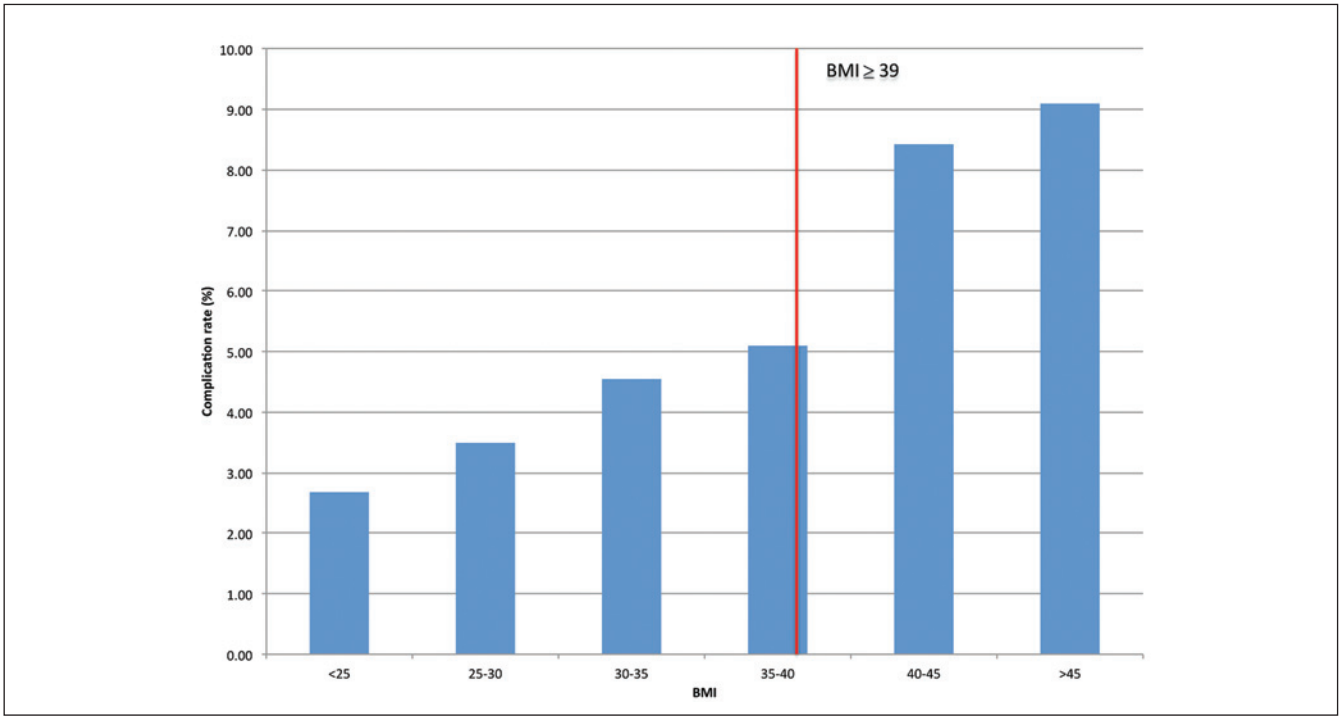

Figure 1. Overall complication rates according to body mass index (BMI) category. BMI ≥39 was associated with a 2.38 greater probability of complications compared with BMI < 39.

DISCUSSION

Reduction mammaplasty is a common reconstructive surgical procedure that is being increasingly performed in patients with high BMI. Of the 2492 patients in the present analysis who underwent breast reduction surgery, only 336 (13%) were considered of normal weight (BMI < 25); 773 patients (31%) were overweight (BMI 25-29.9). More than half of the patients in this study (n = 1383; 55%) were classified as obese by WHO criteria (BMI > 30). This trend

is reflected in the current plastic surgery literature, which states an average BMI of 31[10] and 34[12] for US populations, 27.6 for a British population,[29] 28 for a Finish population,[20] and 27.9 for an adolescent British population.[30]

There has been debate among plastic surgeons about whether increasing BMI correlates with increasing complications after reduction mammaplasty. Zubowski et al[5] reviewed data for 267 bilateral breast reduction patients and found no significant major systemic complications, regardless of BMI. They determined that complication rates were significantly higher among obese patients but that the incidence of complications did not correlate with incremental increases in BMI over 30. Conversely, Setala et al[20] did not find any correlation between obesity and higher risk of postoperative complications in their study of 273 consecutive patients who underwent bilateral breast reduction surgery. The only difference they noted was an increase in areolar necrosis among obese patients: 6% versus 0% for nonobese patients (P = .007). Moreover, they did not observe any major systemic complications. Roehl et al[12] performed a retrospective analysis of 179 reduction mammaplasties and found no statistically significant difference in complication rates based on BMI; however, there was a trend toward increasing complication rates with increasing BMI.

The aim of our study was to help clarify the effect of BMI on postoperative complications. This retrospective cohort analysis of the NQSIP database represents the largest analysis of its type to date. We stratified 2492 patients into 6 groups based on WHO classification, and class 3 obesity was further subdivided into morbid and super obesity based on classifications in the surgical literature. The 6 groups in this study were defined as follows: BMI ≤24.9, normal weight; BMI 25.0-29.9, overweight; BMI 30.0-34.9, class 1 obesity; BMI 35.0-39.9, class 2 obesity (severe obesity in surgical literature); BMI 40.0-44.9, class 3 obesity (morbid obesity in surgical literature); and BMI ≥45.0, class 3 obesity (super obesity in surgical literature).[22-24] Two conclusions can be drawn from the findings of our study. First, the risk of major surgical and medical complications is low, regardless of BMI. This fact is supported by the breast reduction literature. Second, the risk of superficial surgical infection and wound breakdown increases significantly with increasing BMI.

In support of our first conclusion, we found that reduction mammaplasty is safe, even in patients with BMI >45. There were no deaths in our study population, nor were there any instances of pneumonia, pulmonary embolism, prolonged ventilation (>48 hours), renal insufficiency, acute renal failure, coma, stroke, cardiac arrest, or peripheral neural deficit. The rate of medical complications was very low (0.6%). These complications included 1 unplanned intubation, 1 myocardial infarction, 1 deep venous thrombosis, 2 cases of sepsis/shock, 4 urinary tract infections, and 5 blood transfusions. The rate of deep SSI was 0.3%, and the rate of nipple or flap necrosis was 0.1%.

Our first conclusion also is supported in the literature by Webb et al,[30] who compared complication rates by BMI among 67 adolescents. They found that all but 1 complication was minor. The only major complication was an abscess that required surgical drainage. Skin separation and minor wound issues were the most common complications; these occurred in 22% of nonobese patients and 40% of obese patients (P = .11). The second most common complication was altered nipple sensation, which occurred in 13% of nonobese patients and 32% of obese patients (P = .07). The overall infection rate in their study (3%) did not different significantly between the 2 groups. Most important, patient satisfaction with the outcome was 86% for both weight groups. These data are consistent with those of Hanemann and Grotting,[31] who reviewed data from CosmetAssure (Montgomery, Alabama), which provides insurance coverage for major complications of cosmetic surgery. The complications included in their study were those that required admission to a hospital, emergency room, or surgery center for treatment. Among the 904 breast reduction cases studied, there were no significant differences in the overall rate of major complications (2.1% vs 2.0%) or the rate of major infections (1% vs 1%).

The second conclusion of our study, as mentioned above, is that surgical complications increase with increasing BMI. The rate of surgical complications in our study was 4.0%, which increased from 2.4% for BMI <25 to 7.1% for BMI >45 (P = .006). The incidence of superficial SSI was 2.9%, ranging from 2.1% for BMI <25 to 5.1% for BMI >45 (P = .03). The rate of wound disruption was 0.9%. Although the rate of wound disruption did not differ significantly among the BMI categories, there was a trend toward high rates of wound disruption in patients with high BMI.

Our complication rates were lower than those reported by Chun et al,[10] who reviewed 675 consecutive cases of reduction mammaplasty and found a significant increase in complications with increasing BMI. However, our trend for increasing complications followed a similar pattern. In a different study, Chen et al[17] reviewed insurance data following any type of insurance-covered breast surgery for 2403 obese patients and found that reduction mammaplasty was associated with a complication rate of 14.6% among obese patients and 1.7% among nonobese patients. Our results showed a similar trend, with a complication rate of 5.5% for obese patients (BMI >30) and 3.2% for nonobese patients (BMI <30). Our lower rates of complication are likely due to the fact that we did not include the subjective variables (eg, pain, deformity of the breast) that were used by Chen et al.[17] Our results also mirror those of Shah et al,[29] who compared breast reduction patients across 3 BMI groups (<25, 25-29.9, and >30). They found a significant increase in infection, nipple necrosis, any complication, and multiple complications in the groups with high BMI. Again, most of these complications were minor surgical site problems. There were no significant differences in aesthetic outcomes between their study groups.

Finally, our maximal point analysis showed that patients with a BMI of 39 or higher had 2.38 times greater odds of having a complication than patients whose BMI

was 38 or lower. This finding is in agreement with the recent analysis by Chun et al,[10] who found that women with a BMI above 36 had a 2-fold increase in the risk of complication. Further evaluation of reduction mammaplasty outcomes is needed to determine whether high- and low-risk groups can be defined.

It should be noted that, although regression modeling showed a trend toward increased complications for every group with BMI >25, the adjusted odds ratios did not become statistically significant until BMI reached 40 or higher. Although this may imply that reduction mammaplasty is relatively safe for obese patients, it also should prompt further investigation with cohorts large enough to provide greater numbers of the infrequent complications seen in each BMI category.

We believe that these data add to the plastic surgeon's knowledge base for discussing risks with patients who are interested in breast reduction surgery. Most patients who present for breast reduction surgery are overweight or obese, and studies such as ours help the surgeon explain 2 important points to patients: (1) that breast reduction surgery is medically safe and (2) that as BMI increases, so does the risk of surgical site complications. This knowledge will prepare the patient and the surgeon for a potentially longer postoperative course and may lead to improved satisfaction for both, since realistic expectations about postoperative problems would be discussed beforehand.

Data from this review also are important in regard to establishing pay-for-performance criteria. Because the American population is becoming more obese, surgical site complications are, unfortunately, becoming more the norm than the exception. In turn, it is reasonable to surmise that doctors should not be penalized for operating on patients who have a higher risk of complications if the final outcome will be beneficial to the patient.

A limitation of our study is that it did not ascertain whether correlations exist between complication rates and the amount of breast tissue removed, because tissue volume removed is not a variable captured by the NSQIP. Moreover, the fixed definitions of complications used by the NSQIP, although helpful for enhancing generalizability and objectivity, may result in failure to capture certain criteria specific to plastic surgery. For example, percentage of body fat, a factor found by Waisbren et al[32] to be a "more sensitive and precise" predictor of SSI than BMI, is not a variable examined in the NSQIP. Another limitation was our inability to track certain complications (eg, hematoma, seroma) and aesthetic outcomes. Minor skin separations and minor SSI would not have been captured by the NSQIP definitions. In addition, it was difficult to determine whether any of the study patients underwent oncoplastic breast reduction after partial removal of the breast for breast cancer. This fact, in conjunction with the limited follow-up period of 30 days, can be assumed to contribute to our lower rate of complications. Some authors have proposed augmenting the NSQIP data collection system to include a follow-up window of 90 days and to track additional variables specific to plastic surgery, which would permit a more comprehensive analysis of the NSQIP content.[33]

CONCLUSIONS

In the largest study to date comparing BMI breast reduction complication rates and BMI, we found that surgical breast reduction is a safe procedure with a low risk of major complications—even in patients with high BMI. This supports the current practice of performing reduction mammaplasty on patients who are overweight. This practice is further supported by the current surgical literature, which shows that patient satisfaction rates and aesthetic outcomes are comparable for all BMI groups.[29,30]

Our study also showed that the risk of surgical site complications increases with increasing BMI. Although it appears safe to perform reduction mammaplasty on patients with high BMI, it is important for clinicians to fully discuss with appropriate patients the increased risk of surgical site complications. It is also important to include BMI in risk stratifications when developing patient outcome measures for reimbursement and pay-for-performance models, because patients with high BMI are more likely to have surgical site complications, based on BMI alone.

Disclaimer

The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) 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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