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Predictive Patient Characteristics and Surgical Variables That Influence Postoperative Complications following Bilateral Reduction Mammoplasty

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Background: Breast hypertrophy is known to be a source of both physical and psychosocial health deficits. Therefore, the ability to relieve these symptoms with surgical treatment is an important consideration for patients. The primary objective of this study was to assess the impact of patient body mass index (BMI) on postoperation complications. The secondary objective of this study was to assess patient demographics, surgical techniques, and patient comorbidities for their impact on specific postoperative complications.

Methods: A retrospective chart review of all patients who received bilateral breast reduction surgery in Nova Scotia over the past 10 years was performed. A total of 1022 patients met the inclusion criteria of the study. Logistic regression modeling was performed to identify demographic factors, surgical techniques, and patient comorbidities that impact the risk of developing specific postoperative complications.

Results: Our study population had a total complication incidence of 37.7%. BMI was not significantly different between patients who developed complications and those who did not. Logistic regression modeling showed a significant relationship that with each unit increase in BMI above the mean (25.9 kg/m^2) the relative risk of patient-reported postoperative asymmetry increased by 6%.

Conclusions: The findings of this study suggest that BMI has several nonsignificant relationships to postoperative complications following bilateral breast reduction. These trends do not translate to significantly increased complaints of asymmetry, scarring, or revision surgeries. This study also provides valuable information on the timeline of postoperative complications and when they can commonly be identified.
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INTRODUCTION

Breast hypertrophy causes both physical and psychosocial discomfort and health deficits. Letterman and Schurter described the complications of macromastia on the skeletal system, including increased neck strain, aching shoulders, low back pain, and poor posture.[1] Therefore, the ability to relieve these symptoms with surgical treatment is an important consideration for patients. Of the patients who decide to receive breast reduction surgery, studies have shown that the majority choose to do so for symptom relief rather than for cosmetic appearance.[2] The literature has demonstrated that breast reduction surgery is effective in significantly improving quality of life, increasing a patient's capacity to participate in exercise activities, improving emotional stability,[2,3] and relieving the physical symptoms of macromastia.[4]

While breast reduction surgery has many published benefits, there are also well known postoperation complications that can serve as deterrents for patients. Complications following breast reduction surgery have been shown to be as high as 43%–52%.[5–7] Several studies have investigated the risk factors associated with an increased incidence of postoperative complications. Weight of breast tissue resected,[8]

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the addition of liposuction,[9] cardiac disease,[10] active smoking,[10–12] dyspnea,[11] resident participation,[11] inpatient surgery,[11] vertical incision technique,[5] age 60 years or older,[12] previous hysterectomy/oophorectomy,[10] and exogenous hormone supplementation[10] have all been demonstrated to have significant correlation with increased postoperative complications. To date, there has been disagreement in the literature regarding the relationship of patient BMI and postoperative complications. Several articles have demonstrated a relationship between increased BMI and postoperative complications, but have been unable to agree on the BMI cut-off at which there are increased risks of complications.[10–13] Other studies have been unable to demonstrate any relationship between BMI and postoperative complication rates.[6,7]

Interestingly, some provinces in Canada and several insurance companies in the United States of America enforce maximum BMI and minimum breast tissue removal cut-offs to have surgery covered.[14] This creates a counter-intuitive dilemma in that patients with higher BMI are more likely to meet the tissue removal criteria, but less likely to meet the BMI cut-off. It is important to note that increased tissue removal or reduced preoperative BMI have not been shown to correlate with improved patient satisfaction postoperation. Furthermore, the majority of the literature on this topic has focused on a single surgeon or a single center and had limited assessed patient characteristics, few surgical technique descriptions, and limited patient follow-up. This study offers a unique opportunity to investigate the impact of patient characteristics, including BMI on postoperation complications in a large, multicenter, multisurgeon population.

The purpose of this study was to assess the impact of BMI and other patient comorbidities on postoperation complications following breast reduction surgery. We hypothesize that reduced preoperative BMI and tissue removal will decrease the incidence of postoperative complications. If postoperative complications do not correlate with these factors, then this study will bring into question the validity of policies that require a specific preoperative BMI and quantity of tissue to be resected to be eligible for funding.

Takeaways

Question: The primary objective of this study was to assess the impact of BMI on postoperation complications. The secondary objective of this study was to assess patient demographics, surgical techniques, and patient comorbidities for their impact on specific postoperative complications.

Findings: BMI was not significantly different between patients who developed complications and those who did not. Logistic regression modeling showed a significant relationship that with each unit increase in BMI above the mean (25.9) the relative risk of patient-reported asymmetry increased by 6%.

Meaning: Increasing patient BMI does translate to significant increase in patient reported asymmetry. Increasing BMI does not significantly increase the rate of revision or repeat surgeries.

METHODS

After ethics approval by the local research ethics board, a retrospective chart review of patients who underwent breast reduction mammoplasty in Nova Scotia between April 1, 2008 and March 31, 2018 was performed. Patients were identified using billing codes. Surgeries were performed by 13 plastic surgeons at seven surgical centers. All the surgeons included in the study were Canadian-trained and FRCSC-certified. All surgeries were primary breast surgeries.

Included patients must have undergone bilateral breast reduction surgery within the timeframe being assessed. Exclusion criteria included patients with previous breast surgery, congenital breast asymmetry, male gender, unilateral breast reduction, previously diagnosed or existing breast cancer, less than 200 g of breast tissue removed from each breast, missing BMI information, or no recorded postoperative follow-up. The specific indications for surgery of the patients included in this study included physical or psychological symptoms (back, neck or shoulder, or chest pain, bra strap grooving, headaches, intertrigo, headaches, postural issues, difficulty with sleep or exercise, and self-confidence issues with clothing and activity). All patients underwent general endotracheal intubation for surgery.

A thorough chart review was performed on each patient to obtain age at the time of surgery, existing medical conditions, preoperative symptoms, smoking status, and breast measurements. Operative records were reviewed for date of surgery, BMI at the time of surgery, concurrent procedures, amount of breast tissue removed from each breast, whether liposuction was performed, breast reduction technique and pedicle type, and any complications that arose during surgery. Lastly, all patient follow-up notes were categorized by time since the surgery (within 24 hours, >24 hours to 1 week, >1 week to 2 weeks, >2 weeks to 1 month, >1 month to 6 months, >6 months to 1 year, and >1 year), and were assessed for postoperative complications, specifically hematoma, seroma, fat necrosis, skin breakdown, nipple necrosis/ loss of nipple, wound dehiscence, infection, asymmetry, loss of nipple sensation, and any revision procedures that were performed. Infection was defined as any clinical documentation of infection in which the patient was started on antimicrobial therapy. Standard follow-up for our center is at 1 week, 2 weeks, and 1 month postoperatively. Patients are then provided with open access for return visit anytime within the first year and often beyond that.

The information collected was organized into predictive variables that were analyzed for correlation with postoperative complications. Existing comorbidities were categorized into groups (neurologic, cardiovascular, renal, dermatological, respiratory, gastroenterological, musculoskeletal, psychiatric, autoimmune, and bleeding disorders). These themed comorbidities, along with some historically high risk medical conditions (hypertension, diabetes, dyslipidemia), age at time of surgery, BMI, average breast tissue removed, number of children, smoking status at time of surgery, surgical technique used, if liposuction was

utilized, and type of pedicle, were analyzed for correlation with each of the possible postoperative complications.

Statistical Analysis

Descriptive statistics were used to analyze patient and postoperative complication characteristics. Categorical variables were expressed as frequency and percentage and continuous variables were expressed as mean ± SD. The differences between patients with and without any complication were analyzed using chi-squared test or Mann-U Whitney test. Patient BMIs were subdivided into five groups for comparative analysis (<20 kg/m^2, 20 kg/m^2 to <25 kg/m^2, 25 kg/m^2 to <30 kg/m^2, 30 kg/m^2 to <35 kg/m^2, and ≥35 kg/m^2). A full logistic regression model with all predictor variables was run for each outcome variable (postoperative complication), and then a stepwise backward selection was performed to find the optimal model. All analyses were performed in R (R Core Team, University of Auckland, New Zealand) and a *P* value of 0.05 or less was considered as statistical significance.

RESULTS

Through billing codes, 1871 patients were identified who received elective bilateral breast reductions. Of these patients, 1022 patients (mean age 43.4±13.3 years, range 15–74) met the inclusion criteria (Fig. 1). Table 1 demonstrates the demographic characteristics and surgical techniques of the included patients. Average BMI was 25.9 kg/m^2 ± 3.7 kg/m^2 (range 16.6–48.3 kg/m^2). Initial consultation notes revealed that the most common preoperative symptoms patients complained of were back pain (87.2%), neck pain (74.8%), shoulder pain (72.6%), and shoulder grooving from bra straps (33.0%). Nipple-to-sternal notch was recorded for 561 patients (54.9%), and was an average of 29.8 cm (range 20–43 cm).

Patients were divided into five BMI groups (<20 kg/m^2, 20 kg/m^2 to <25 kg/m^2, 25 kg/m^2 to <30 kg/m^2, 30 kg/m^2 to <35 kg/m^2, ≥35 kg/m^2). Average breast tissue resected from each breast increased from 383.1 g ± 140.1 g in the smallest BMI group, up to 1271.69 g ± 719.27 g in the largest group. The total number of patients who developed at least one complication postoperatively also increased across the BMI groups from 36.7% in the smallest group, to 50.0% in the largest group, but this was not statistically significant (Table 2). Reported medical comorbidities of the included patients revealed that depression was the most common medical comorbidity (23.3%), followed by gastroesophageal reflux disease (16.5%), hypertension (14.1%), and hypothyroidism (13.6%). Patients actively smoking at the time of surgery made up a small portion of the overall population (8.2%).

Most patients were treated with a Wise pattern reduction technique (71.1%). The type of parenchymal pedicle used was most commonly an inferior parenchymal pedicle (67.6%), followed by superomedial parenchymal pedicle (27.2%). Liposuction was performed in 239 patients (23.4%), with an average of 320.8 g ± 178.1 g (range 10–1000 g) removed in addition to their surgical reduction. For the patients who received liposuction, it was most often associated with a vertical skin reduction technique and a superior-medial parenchymal pedicle (79.9%).

A slim majority (561, 54.9%) of the patients were treated at a teaching hospital and therefore likely had resident involvement in their care. There was no statistically significant increase in complication rate of any kind with patients treated at a teaching hospital compared with elsewhere. Patients had an average of three postoperative follow-up assessments. The percentage of patients seen in follow-up in the first 24 hours was 22.9%, within 1-week 23.9%, between 1 and 2 weeks 55.4%, between 2 weeks and 1 month 44.2%, between 1 month and 6 months 51.4%, between 6 months and 1 year 22.1%, and after 1 year 14.4%. The overall incidence of a patient developing any complication postoperatively was 37.7% (n = 385). The most common complication reported was wound dehiscence (10.1%), followed by unsightly, painful scarring (7.8%), and hematoma (7.7%). Seventy-three patients underwent a repeat operation; of these, hematoma evacuation requiring immediate return to the operating room was required for 23 (2.3%) patients. Delayed revision surgery was performed on 42 (4.1%) patients for complaints of asymmetry or severe scarring. Three patients underwent revision surgery for fat necrosis. The frequency of all complications in addition to the period during follow-up at which the complication presented can be found in Figure 2.

Direct comparison of BMI between patients who developed any complication postoperatively and those who did not was not statistically significant ($P = 0.090$). Multivariate logistic regression indicated that increasing BMI was a predictable variable for the development of any complication ($P = 0.106$), fat necrosis ($P = 0.064$), infection (0.080), but only reached statistical significance for patient-reported asymmetry (0.048). This in turn translated to a nonsignificant relationship that with each unit increase in BMI above the mean (25.9 kg/m^2) the relative risk of any postoperative complication, of fat necrosis and of infection increased by 3%, 7%, and 6%, respectively. The predictive variables for each postoperative complication can be found in Table 3. The Hosmer and Lemeshow test was not significant for each model, indicating that each of the models tested were fit.

DISCUSSION

The relationship of patient BMI and the development of postoperative complications following breast reduction remains a topic of active debate. A recent systematic review performed by Myung and colleagues[15] identified 26 studies investigating BMI and its relationship to postoperative complications following reduction mammoplasty. Of the studies they reviewed, 11 studies found no significant relationship and 15 studies found a significant relationship. After pooling the collected data for 12 of these studies, Myung and colleagues demonstrated that the relative risk of developing a surgical complication was higher in patients with BMI greater than 30 kg per m^2.[15] This finding was supported by a recent meta-analysis that found a significant increase in infections and postoperative complications in patients with a BMI greater than kg per m^2.[16] However, important to note, both of these studies

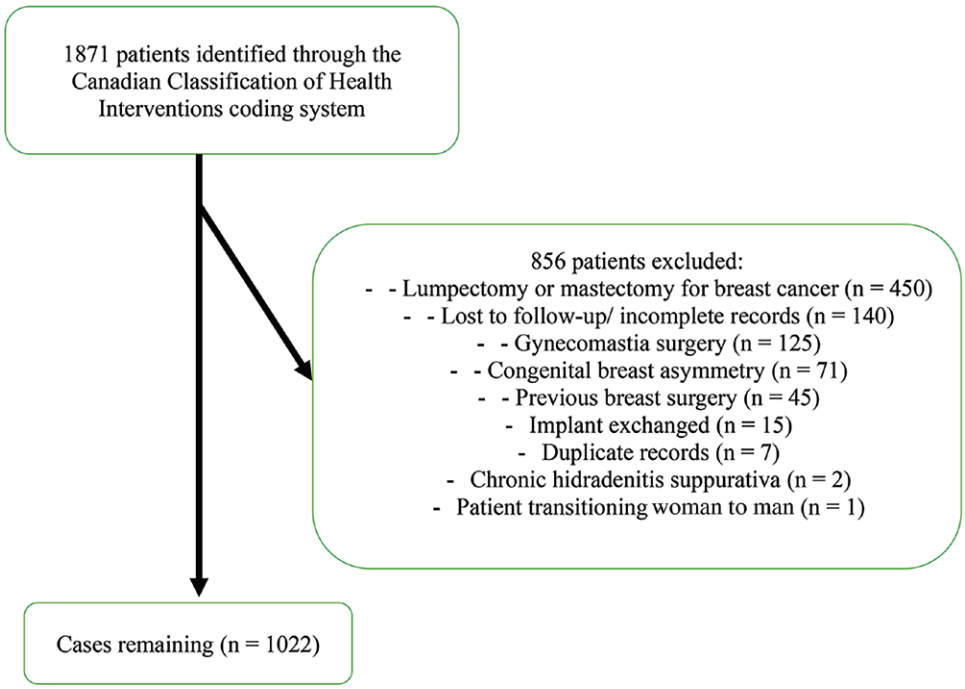


Fig. 1. Selection and exclusion criteria of the study patient population.

identified that many of the reviewed articles did not consider potential confounders such as resection weight, smoking status, surgical technique, were from a single institution, and did not assess specific complication types.

Since the publication of the previously referenced systematic review and meta-analysis, there have been five studies that looked at postoperative complications and its relation to BMI. Two studies found that obesity was not associated with risk of postoperative complications.[17,18] Contradicting these results, one study found that as BMI increased by one point, the risk of infection increased by 16.4%.[19] Similarly, Simpson and colleagues demonstrated that obesity affected local wound complications, reoperations, and unplanned readmission.[20] Lastly, one study found there was a nonsignificant increase in the proportion of patients who developed at least one postoperative complication across ascending BMI groups.[21] Our study reiterates some of these findings and elaborates on details of the relation of BMI to specific postoperative complications. We found that with each increase in BMI by one the overall risk of a complication increased by 3%, and the chance of fat necrosis, infection or asymmetry postoperatively increased by 7%, 6%, and 6%, respectively. Interestingly, the increased relative risk of these complications did not correlate to a significant increase in scarring or revision surgeries. Thus, demonstrating that the patients developing those complications were successfully treated without a significant increase in long-term complications or repeat surgeries. However, an important aspect of patient care is the impact of complications on increased days off work, cost accrued by employers or insurance companies,

Table 1. Comparison of Patient Demographics, Comorbidities and Surgical Variables between Patients Who Suffered Postoperative Complications and Those Who Did Not

	All Patients (n = 1022)	Patients with Complications (n = 385)	Patients without Complications (n = 637)	*P*
Age at time of surgery	43.4±13.3	43.9±13.3	43.2±13.3	0.419
Height (cm)	165.0±9.9	165.1±10.2	164.8±9.4	0.552
Weight (kg)	70.2±9.6	69.9±9.5	70.6±9.7	0.261
Body mass index (kg/m²)	25.9±3.7	26.1±3.8	25.7±3.6	0.090
Active smoker	84 (8.2%)	37 (9.6%)	47 (7.4%)	0.208
Wise technique performed	727 (71.1%)	274 (71.2%)	453 (71.1%)	0.985
Liposuction performed	239 (23.4%)	75 (19.5%)	164 (25.7%)	**0.022**
Inferior pedicle	691 (67.6%)	254 (66.0%)	437 (68.6%)	0.385
Superiormedial pedicle	278 (27.2%)	105 (27.3%)	173 (27.2%)	0.925
Superior pedicle	11 (1.1%)	4 (1.0%)	7 (1.1%)	0.928
Lateral pedicle	18 (1.8%)	12 (3.1%)	6 (0.9%)	**0.010**
Medial pedicle	14 (1.4%)	5 (1.3%)	9 (1.4%)	0.879
Central pedicle	3 (0.3%)	1 (0.3%)	2 (0.3%)	0.300
Superiorlateral pedicle	7 (0.7%)	4 (1.0%)	3 (0.5%)	0.287
Average breast tissue removed	618.6±316.4	628.1±367.7	612.9±281.1	0.457

Bolded values are stastically significant.

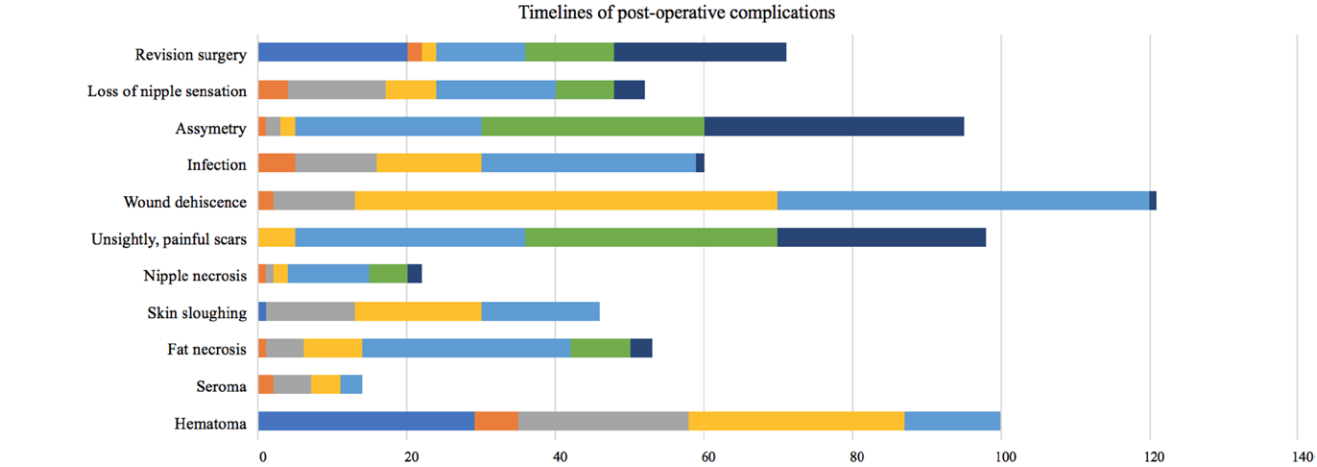
Table 2. Distribution of Postoperative Complications and Surgical Variables Categorized by Body Mass Index

	<20 kg/m²	20 kg/m² to <25 kg/m²	25 kg/m² to <30 kg/m²	30 kg/m² to <35 kg/m²	> 35 kg/m²
n	30	384	519	59	30
Age	41.63±14.03	41.14±13.61	44.52±12.59	48.08±12.99	46.73±18.45
BMI	18.99±0.94	23.27±1.25	26.70±1.19	32.03±1.39	39.16±3.92
Breast tissue	383.1±140.1	548.56±267.25	611.89±260.17	737.33±318.52	1271.69.08±719.27
Patients that developed at least one complication	11 (36.7%)	134 (34.9%)	199 (38.3%)	26 (44.1%)	15 (50.0%)
Hematoma	2 (6.7%)	35 (9.1%)	36 (6.9%)	4 (6.8%)	2 (6.7%)
Seroma	1 (3.3%)	2 (0.5%)	8 (1.5%)	1 (1.7%)	2(6.7%)
Fat necrosis	0 (0.0%)	11 (2.9%)	26 (5.0%)	8 (13.6%)	4 (13.3%)
Skin sloughing	0 (0.0%)	9 (2.3%)	21 (4.0%)	5 (8.5%)	3 (10.0%)
Nipple necrosis	0 (0.0%)	6 (1.6%)	10 (1.9%)	2 (3.4%)	0 (0.0%)
Unsightly, painful scar	3 (10.0%)	32 (8.3%)	40 (7.7%)	3 (5.1%)	2 (6.7%)
Wound dehiscence	5 (16.7%)	28 (7.3%)	59 (11.4%)	6 (10.2%)	5 (16.7%)
Infection	0 (0.0%)	20 (5.2%)	29 (5.6%)	5 (8.5%)	2 (6.7%)
Asymmetry	1 (3.3%)	24 (6.3%)	42 (8.1%)	4 (6.8%)	4 (13.3%)
Loss of nipple sensation	0 (0.0%)	18 (4.7%)	19 (3.7%)	1 (1.7%)	3 (10.0%)
Immediate revision	0 (0.0%)	7 (1.8%)	15 (2.9%)	0 (0.0%)	0 (0.0%)
Delayed revision	1 (3.3%)	11 (2.9%)	30 (5.8%)	3 (5.1%)	2 (6.7%)

short-term morbidity (pain and suffering) of the patient, and the overall cost to the healthcare system. These factors may be impacted by patient BMI, and to-date have not been adequately assessed in the literature.

Historically, comparison of Wise pattern reductions and vertical skin reduction techniques has demonstrated no significant difference in the development of postoperative complications.[6,10,17,22] One study found that a vertical reduction improved scarring and breast projection.[22,23] Another found that a vertical reduction can be effectively used in all cases of breast reductions with good, stable results.[9] Interestingly, we found that the relative risk of developing unsightly, painful scars and asymmetry was significantly higher for vertical reductions. Furthermore, we found that vertical skin reduction techniques with superomedial pedicle had a significantly higher relative risk of developing a seroma postoperatively. This finding is similar to that of Setälä and colleagues, who demonstrated that a superior pedicle was more frequently associated with seroma formation.[6] These findings may represent a learning curve, as our data demonstrated an increase uptake in the use of vertical reduction techniques over the 10-year period of the study. Additionally, our findings agree with other literature that the addition of liposuction to a breast reduction procedure was not a predictor of major complications.[20] Interestingly, we found that liposuction was related to significantly less postoperative complications, specifically hematomas, scarring, asymmetry, and nipple necrosis.

Several studies noted findings consistent with ours, that the total amount of breast tissue resected increased as BMI increased.[6,21] The literature has also assessed the correlation between the amount of breast tissue resected and the



	Hematoma	Seroma	Fat necrosis	Skin sloughing	Nipple necrosis	Unsightly, painful scars	Wound dehiscence	Infection	Assymetry	Loss of nipple sensation	Revision surgery
Within 24 hours post-operation	29	0	0	1	0	0	0	0	0	0	20
24 hours to 1 week post-operation	6	2	1	0	1	0	2	5	1	4	2
1 week to 2 weeks post-operation	23	5	5	12	1	0	11	11	2	13	0
2 weeks to 1 month post-operation	29	4	8	17	2	5	57	14	2	7	2
1 month to 6 months post-operation	13	3	28	16	11	31	50	29	25	16	12
6 month to 1 year post-operation	0	0	8	0	5	34	0	0	30	8	12
Over 1 year post-operation	0	0	3	0	2	28	1	1	35	4	23

Fig. 2. Timeline and frequency of each postoperative complication.

Table 3. The Results of the Logistic Regression Models for Each Specific Postoperative Complication That Was Assessed

	Odds Ratio	95% Confidence Interval	*P*
Any complication	**X2, 4.416, 0.144**		
Body mass index (kg/m²)	1.03	0.99–1.07	0.106
MSK/chronic pain disorders	1.67	1.09–2.54	0.018
Autoimmune disorders	2.40	1.13–5.09	0.023
Liposuction performed	0.62	0.45–0.86	0.004
Vertical reduction technique	1.39	0.97–2.01	0.075
Hematoma	**X2, 3.022, 0.933**		
Age at time of surgery	1.03	1.01–1.05	0.007
Bleeding disorders	1.88	0.80–4.37	0.146
Liposuction performed	0.43	0.51–0.263	0.043
Seroma	**X2, 8.540, 0.383**		
Average breast tissue removed	1.00	1.00–1.01	0.003
No. children	1.58	1.05–2.38	0.028
Diabetes	6.15	1.24–30.41	0.026
Vertical reduction technique	8.59	1.97–35.49	0.003
Fat necrosis	**X2, 6.725, 0.567**		
Age at time of surgery	1.04	1.01–1.07	0.002
Body mass index (kg/m²)	1.07	0.99–1.14	0.064
Average breast tissue removed	1.00	1.00–1.01	0.017
Dermatologic disorders	3.19	0.86–11.8	0.083
Hormone medication	1.98	0.88–4.44	0.097
Skin sloughing	**X2, 3.229, 0.919**		
Average breast tissue removed	1.00	1.00–1.01	0.010
Dyslipidemia	2.92	1.27–6.71	0.011
Vertical reduction technique	0.28	0.10–0.79	0.016
Nipple necrosis	**X2, 0.386, 0.825**		
Dyslipidemia	3.55	1.14–11.12	0.029
Liposuction performed	0.182	0.02–1.38	0.182
Unsightly, painful scars	**X2, 11.634,0.168**		
Average breast tissue removed	1.00	1.00–1.01	0.094
Autoimmune disorders	3.09	1.18–8.14	0.023
Bleeding disorders	2.08	0.89–4.84	0.091
Hypertension	1.74	0.97–3.14	0.065
Liposuction performed	0.18	0.09–0.39	<0.001
Vertical reduction technique	4.77	2.72–8.36	<0.001
Wound dehiscence	**X2 5.139, 0.743**		
Age at time of surgery	1.02	0.99–1.03	0.087
Hormone medication	1.56	0.90–2.68	0.116
Vertical reduction technique	0.57	0.34–0.96	0.033
Infection	**X2 5.83, 0.667**		
Body mass index (kg/m²)	1.06	0.99–1.13	0.080
Pedicle	1.23	0.96–1.58	0.098
Autoimmune disorders	3.49	1.27–9.57	0.015
Vertical reduction technique	0.55	0.27–1.10	0.098
Asymmetry	**X2 5.31, 0.724**		
Body mass index (kg/m²)	1.06	1.01–1.13	0.048
MSK/chronic pain disorders	2.10	1.07–4.13	0.032
Psychiatric/behavioral disorders	0.57	0.31–1.06	0.76
Inferior pedicle	1.31	1.06–1.63	0.013
Liposuction performed	0.39	0.20–0.76	0.006
Vertical reduction technique	3.36	1.81–6.26	<0.001
Loss of nipple sensation	**X2 6.248, 0.619**		
Age at time of surgery	0.97	0.95–0.99	0.012
Active smoker	2.31	0.93–5.75	0.073
Cardiovascular disorders	3.42	1.33–8.77	0.011
MSK/chronic pain disorders	2.51	1.04–6.06	0.040
Delayed revision	**X2 11.76, 0.162**		
Age at time of surgery	1.03	1.00–1.05	0.030
Average breast tissue removed	1.00	1.00–1.00	0.002
Vertical reduction technique	0.42	0.17–1.01	0.054

development of postoperative complications,[5,8,24,25] specifically nipple necrosis or fat necrosis.[6,19] Contradicting these findings, several studies have found no significant relationship between complications and resected tissue volume.[10,18] The meta-analysis by Zhang and colleagues demonstrated that there was no significant increase in postoperative complications in patients who had greater than 1000 g resected.[16] Our study expands on these findings and demonstrates that the average amount of tissue removed from each breast was not significantly different between patients who developed postoperative complications and those who did not. Additionally, logistic regression modeling demonstrated that the average breast tissue removed was not a predictive variable for the development of any postoperative complication.

Limitations

This study has several limitations. The retrospective nature of this study resulted in some patients being lost to follow-up and excluded for incomplete records. Furthermore, there is innate variability in the surgical technique, skills, experience, and reporting habits of each surgeon included in this study. Another limitation is the lack of description of the breast tissue itself. Postoperative complications may correlate to breasts that are more dense or glandular compared

with fatty breast, but this was not routinely recorded. Similarly, due to the retrospective nature of the clinic notes, complications were determined based on documentation and severity of complication (fat necrosis, seroma, infection, wound dehiscence) was often not discernable. The designation of patients to the surgical technique was not randomized. Therefore, there are likely confounders that limit the outcomes of this study. Lastly, we did not have data available to us to assess the impact of patient BMI on increased days off work and the cost accrued by employers or insurance companies, cost to the healthcare system, the short-term morbidity (pain and suffering) of the patient, and rates of litigation. Despite these limitations, the multicenter aspect of the study and large study population do promote the ability to extrapolate on the results presented. A strength of this study is the detailed analysis of each specific postoperative complication. Many studies to date have a focus on the development of "any complication" and have not further assessed each complication individually.

CONCLUSIONS

The findings of this 10-year study suggest that BMI has several nonsignificant relationships to postoperative complications following bilateral reduction mammoplasty. Interestingly, these trends do not translate to significantly increased complaints of asymmetry, scarring, or revision surgeries. This suggests that the postoperative complications are being adequately treated. This study also provides valuable information on surgical techniques, patient demographics, and comorbidities that increase a patient's risk for postoperative complications.

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REFERENCES

1. Letterman G, Schurter M. The effects of mammary hypertrophy on the skeletal system. *Ann Plast Surg.* 1980;5:425–431.
2. Boschert MT, Barone CM, Puckett CL. Outcome analysis of reduction mammaplasty. *Plast Reconstr Surg.* 1996;98:451–454.
3. Iwuagwu OC, Walker LG, Stanley PW, et al. Randomized clinical trial examining psychosocial and quality of life benefits of bilateral breast reduction surgery. *Br J Surg.* 2006;93:291–294.
4. Davis GM, Ringler SL, Short K, et al. Reduction mammaplasty: long-term efficacy, morbidity, and patient satisfaction. *Plast Reconstr Surg.* 1995;96:1106–1110.
5. Cunningham BL, Gear AJ, Kerrigan CL, et al. Analysis of breast reduction complications derived from the BRAVO study. *Plast Reconstr Surg.* 2005;115:1597–1604.
6. Setälä L, Papp A, Joukainen S, et al. Obesity and complications in breast reduction surgery: are restrictions justified? *J Plast Reconstr Aesthet Surg.* 2009;62:195–199.
7. Roehl K, Craig ES, Gómez V, et al. Breast reduction: safe in the morbidly obese? *Plast Reconstr Surg.* 2008;122:370–378.
8. Zubowski R, Zins JE, Foray-Kaplon A, et al. Relationship of obesity and specimen weight to complications in reduction mammaplasty. *Plast Reconstr Surg.* 2000;106:998–1003.
9. Lejour M. Vertical mammaplasty and liposuction of the breast. *Plast Reconstr Surg.* 1994;94:100–114.
10. Manahan MA, Buretta KJ, Chang D, et al. An outcomes analysis of 2142 breast reduction procedures. *Ann Plast Surg.* 2015;74:289–292.
11. Fischer JP, Cleveland EC, Shang EK, et al. Complications following reduction mammaplasty: a review of 3538 cases from the 2005-2010 NSQIP data sets. *Aesthet Surg J.* 2014;34:66–73.
12. Wirthmann AE, Welsch L, Wellenbrock SV, et al. Reduction mammoplasty in adolescents and elderly: a ten year case series analyzing age related outcome with focus on safety and complications. *J Plast Reconstr Aesthet Surg.* 2018;71:377–383.
13. Gulcelik MA, Dogan L, Camlibel M, et al. Early complications of a reduction mammoplasty technique in the treatment of macromastia with or without breast cancer. *Clin Breast Cancer.* 2011;11:395–399.
14. Wagner DS, Alfonso DR. The influence of obesity and volume of resection on success in reduction mammaplasty: an outcomes study. *Plast Reconstr Surg.* 2005;115:1034–1038.
15. Myung Y, Heo CY. Relationship between obesity and surgical complications after reduction mammaplasty: a systematic literature review and meta-analysis. *Aesthet Surg J.* 2017;37:308–315.
16. Zhang MX, Chen CY, Fang QQ, et al. Risk factors for complications after reduction mammoplasty: a meta-analysis. *PLoS One.* 2016;11:e0167746.
17. Ogunleye AA, Leroux O, Morrison N, et al. Complications after reduction mammaplasty: a comparison of wise pattern/inferior pedicle and vertical scar/superomedial pedicle. *Ann Plast Surg.* 2017;79:13–16.
18. Nuzzi LC, Firriolo JM, Pike CM, et al. Complications and quality of life following reduction mammaplasty in adolescents and young women. *Plast Reconstr Surg.* 2019;144:572–581.
19. Winter R, Reischies FMJ, Tuca A, et al. BMI and specimen weight: impact on personalized risk profiling for optimized informed consent in breast reduction surgery? *Sci Rep.* 2019;9:12690.
20. Simpson AM, Donato DP, Kwok AC, et al. Predictors of complications following breast reduction surgery: a national surgical quality improvement program study of 16,812 cases. *J Plast Reconstr Aesthet Surg.* 2019;72:43–51.
21. Tomczyk ERG, Chappell A, Erskine N, et al. Effect of obesity on complications in short-scar breast reduction: a retrospective study of 236 consecutive patients. *Plast Surg (Oakv).* 2018;26:238–243.
22. Cruz-Korchin N, Korchin L. Vertical versus Wise pattern breast reduction: patient satisfaction, revision rates, and complications. *Plast Reconstr Surg.* 2003;112:1573–1578; discussion 1579.
23. Antony AK, Yegiyants SS, Danielson KK, et al. A matched cohort study of superomedial pedicle vertical scar breast reduction (100 breasts) and traditional inferior pedicle Wise-pattern reduction (100 breasts): an outcomes study over 3 years. *Plast Reconstr Surg.* 2013;132:1068–1076.
24. Shah R, Al-Ajam Y, Stott D, et al. Obesity in mammaplasty: a study of complications following breast reduction. *J Plast Reconstr Aesthet Surg.* 2011;64:508–514.
25. Dabbah A, Lehman JA Jr, Parker MG, et al. Reduction mammaplasty: an outcome analysis. *Ann Plast Surg.* 1995;35:337–341.