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A Multi-Institutional Perspective of Complication Rates for Elective Nonreconstructive Breast Surgery: An Analysis of NSQIP Data From 2006 to 2010

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Abstract

Background: As elective nonreconstructive breast surgery increases in popularity, there is greater demand for accurate multi-institutional data on minor and major postoperative complications.

Objective: The authors utilized a multi-institutional database to compare 30-day morbidities and reoperation rates among the different types of elective nonreconstructive breast surgery.

Methods: Patients in the National Surgical Quality Improvement Program (NSQIP) participant use file who underwent elective nonreconstructive breast surgery between 2006 and 2010 were identified. Twenty defined morbidities were compared among mastopexy, reduction mammoplasty, and augmentation mammoplasty patients using analysis of variance and χ^2 tests for continuous variables and categorical variables, respectively. Logistic regression modeling was employed to identify preoperative risk factors for complications.

Results: Of the 3612 patients identified, 380 underwent mastopexy, 2507 underwent reduction mammoplasty, and 725 underwent augmentation mammoplasty. Complication rates were low in all cohorts, and patients undergoing augmentation mammoplasty had the lowest overall complication rate compared with mastopexy and reduction mammoplasty (1.24%, 2.37%, and 4.47%). Patients undergoing reduction mammoplasty had a modestly elevated incidence of overall morbidity, superficial surgical site infections, and wound disruptions ($P < .05$). Moreover, 30-day reoperation rates for mastopexy, reduction mammoplasty, and augmentation mammoplasty were low (1.58%, 2.07%, and 0.97%), as were the rates of life-threatening complications (0%, 0.16%, and 0%). One death was observed for all 3612 procedures (0.03%).

Conclusions: Elective breast surgery is a safe procedure with an extremely low incidence of life-threatening complications and mortality. Comprehensive data collated from the NSQIP initiative add to the literature, and the findings of this multi-institutional study may help further guide patient education and expectations on potentially deleterious outcomes.

Level of Evidence: 3

Keywords

elective breast surgery, mastopexy, reduction mammoplasty, augmentation mammoplasty, NSQIP, outcomes, cosmetic breast surgery, complications

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Mastopexy, augmentation mammoplasty, and reduction mammoplasty rank among the most frequently performed elective and/or cosmetic plastic surgery procedures in the United States each year. Despite the fact that over 550 000 of these procedures were performed in 2011,¹ the vast majority of the outcomes research regarding mastopexy, augmentation mammoplasty, and reduction mammoplasty has focused on reports from a single surgeon or single group's experience, which only offers a narrow view of the potential outcomes from these procedures.²⁻²³ Multicenter

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data present the results of large series of patients across diverse geographical regions, which helps to account for differences in surgical technique and gives a well-balanced view of the risk profiles of these procedures. However, there are currently limited multicenter data evaluating these potential outcomes. For example, the Tracking Operations and Outcomes for Plastic Surgeons (TOPS) initiative was developed specifically to monitor the quality of plastic surgery. However, data from this registry are self-reported and not subject to auditing, which can introduce bias.²⁴ Another multi-institutional database, CosmetAssure, provides analysis of complications from cosmetic procedures but only reports data on complications requiring an emergency room visit, hospitalization, or reoperation.^{24,25}

More recently, the National Surgical Quality Improvement Program (NSQIP) was established with the purpose of improving the quality of surgical care. This registry prospectively collects validated data from over 200 medical institutions across the United States, resulting in a diverse population that allows for a broad and comprehensive analysis. Numerous studies have documented the program's success in decreasing morbidity and mortality rates, shortening length of stay, and improving patient satisfaction in the public and private sectors.²⁶⁻²⁹

To our knowledge, only 1 study to date has queried the NSQIP data set from a plastic surgery to date perspective.³⁰ Although the lack of breast surgery-specific variables captured by NSQIP has been highlighted, the unique data set captures numerous points that are relevant for outcomes research in plastic surgery. The objective of this study was to further characterize mastopexy, reduction mammoplasty, and augmentation mammoplasty outcomes using NSQIP data and to compare these with existing morbidity data to provide a more comprehensive description of the outcomes from a multi-institutional perspective.

METHODS

For the purposes of this study, breast reduction was considered a cosmetic procedure, although in clinical practice breast reduction often may meet the criteria to be considered a non-cosmetic operation. Notably, reduction volume data was not captured by the NSQIP database. A retrospective analysis was conducted using the NSQIP participant use files from 2006 to 2010. The data collection methods for NSQIP have been extensively described previously.^{31,32} In brief, NSQIP prospectively collects comprehensive patient data, including demographics, preoperative comorbidities and laboratory values, intraoperative details, and postoperative outcomes, within 30 days of the primary operation. Patients are selected based on a systematic sampling cycle that rotates every 8 days to ensure a broad and representative sample of procedures is captured. To ensure accuracy, participating sites are audited, and surgical certified reviewers (SCR) are rigorously trained to extract patient information according to standardized definitions.

Patients undergoing nonreconstructive elective breast surgery were identified using the primary *Current Procedural*

Terminology (CPT) codes for mastopexy (19316), reduction mammoplasty (19318), and augmentation mammoplasty (19325). Males and patients without sex information were excluded. Patients undergoing additional procedures were also excluded. The inclusion process for this study is outlined in Figure 1. The outcomes of interest were postoperative morbidity, mortality, and reoperation. Morbidities included the following: superficial surgical site infection (SSI), deep SSI, organ space SSI, wound disruption, pneumonia, unplanned reintubation, pulmonary emboli, ventilator dependence > 48 hours, progressive renal insufficiency, acute renal failure, urinary tract infection, stroke, coma, cardiac arrest, myocardial infarction, bleeding requiring transfusions, deep venous thrombosis (DVT), sepsis, septic shock, and graft/prosthesis/flap failure. The standards for each complication were used, as defined in the NSQIP user guide.³²

Descriptive statistics were calculated for the study population. Chi-square tests were used to analyze cohorts across categorical variables, and analysis of variance (ANOVA) tests were used for continuous variables. Pairwise *z* tests were performed to compare intercohort proportions. In addition, multivariate logistic regression modeling was used to identify potential risk factors for overall complication within 30 days. Preoperative variables that were included in the models were as follows: age, length of surgery, obesity (defined as a body mass index [BMI] > 25), smoking within 1 year of the operation, diabetes mellitus, chemotherapy within 30 days, dyspnea, hypertension (defined as a persistent elevation of systolic blood pressure > 140 mm Hg or a diastolic blood pressure > 90 mm Hg or patients requiring antihypertensive medication at the time the patient is being considered for surgery), and chronic steroid use (defined as patients who required regular administration of oral or parenteral corticosteroid medications within 30 days prior to surgery for a chronic medical condition). A 2-tailed *P* value of less than .05 was considered significant for all analyses. All data analyses were performed using SPSS version 20.0 (SPSS, Inc, an IBM Company, Chicago, Illinois).

RESULTS

A total of 3612 patients were identified, of whom 380 underwent mastopexy, 2507 underwent reduction mammoplasty, and 725 underwent augmentation mammoplasty. The mean (SD) age of mastopexy, reduction, and augmentation patients was 46.7 (12.5) years, 42.2 (14.0) years, and 36.4 (10.9) years, respectively. Descriptive statistics for the study population are summarized in Table 1.

On review, 130 (3.60%) patients experienced ≥ 1 morbidity, and 1 (0.03%) patient died. Overall morbidity was low in all cohorts but modestly elevated in reduction mammoplasty patients (4.47%) as compared with the mastopexy and augmentation groups (Table 2). In particular, individual outcomes for superficial SSI and wound complications revealed a statistically significant elevation in the reduction mammoplasty cohort as compared with augmentation patients ($P < .05$; Table 2). The median

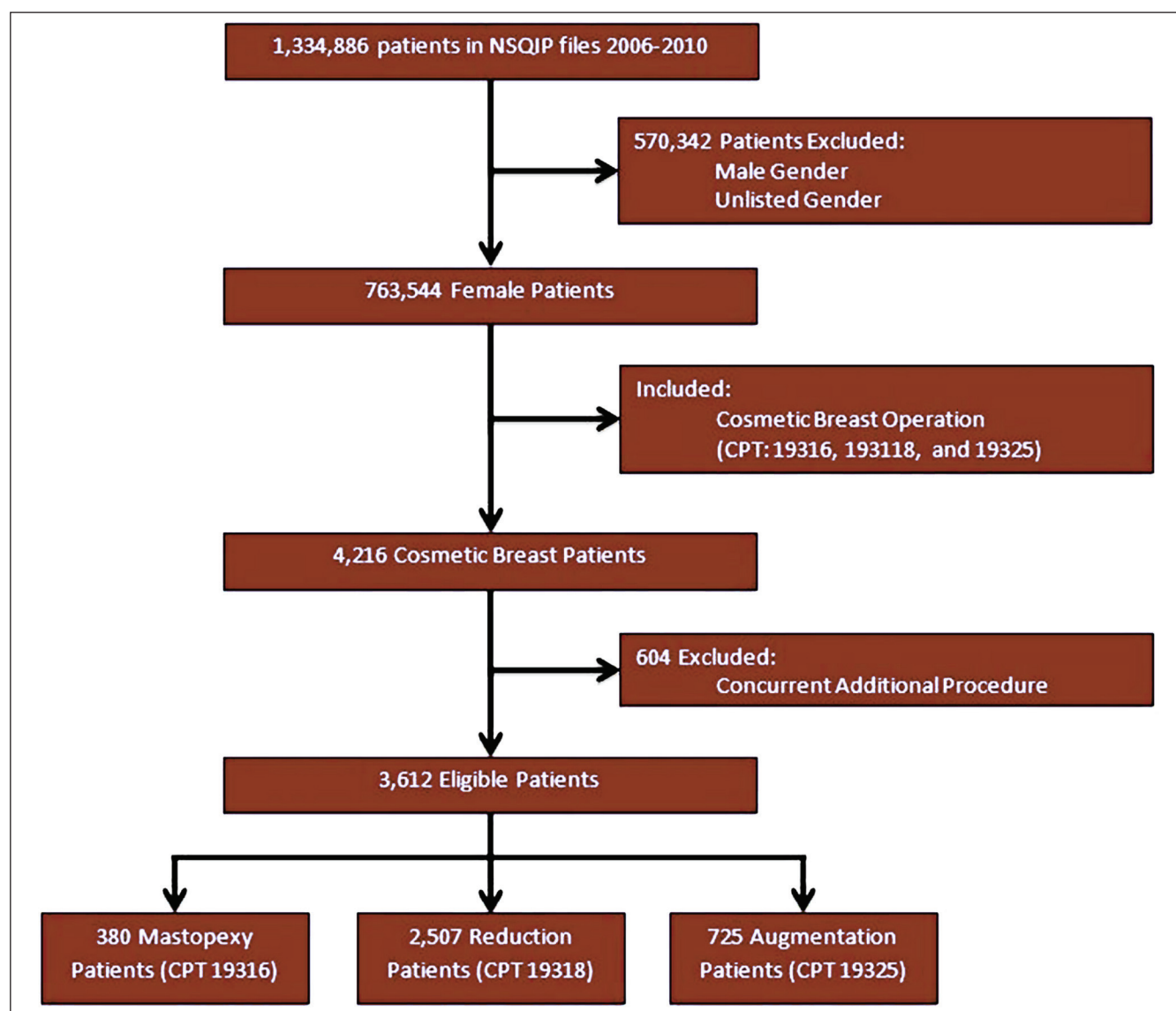


Figure 1. Study attrition diagram. CPT, *Current Procedural Terminology*; NSQIP, *National Surgical Quality Improvement Program*.

time to diagnosis for SSI occurred approximately 2 weeks after the index operation in all groups, ranging from 11 to 21 days. No incidences of pneumonia, pulmonary embolism, ventilator dependence, progressive and acute renal failure, coma, cardiac arrest, or septic shock were observed.

Life-threatening complications (pulmonary embolism, cardiac arrest, myocardial infarction, DVT, and sepsis or septic shock) were low for all groups and did not differ significantly among groups (Table 2). Overall, 65 (1.80%) patients returned to the operating room within 30 days of the index operation, but no statistical difference was observed in reoperation rates among procedure types (Table 2).

Obese patients demonstrated at least a 1.5-fold increase in overall morbidity rate in all 3 cohorts compared with

nonobese patients; however, when included in the multivariate regression models, this association was deemed significant only for the augmentation mammoplasty cohort (Table 3). Diabetics also demonstrated elevated levels of morbidity, but this trend was not shown to be statistically significant in regression models. Patient age did not have a significant effect on adverse outcomes across all cohorts (Table 3). Length of surgery was associated with increased morbidity in the reduction and augmentation groups ($P = .026$ and $P = .003$, respectively). In addition, smoking was significantly associated with increased risk of complications in mastopexy patients (odds ratio [OR], 4.656), and dyspnea was associated with increased morbidity in the reduction cohort (OR, 2.37).

Table 1. Characterization of the Study Population

	Reduction Mammoplasty (n = 2507)	Mastopexy (n = 380)	Augmentation Mammoplasty (n = 725)
Age, y, mean (SD)	42.19 (13.97)	46.66 (12.53)	36.38 (10.87)
Race, No. (%)			
White	1536 (61.3)	280 (73.7)	506 (69.8)
African American	487 (19.4)	24 (6.3)	18 (2.5)
Other	484 (19.3)	76 (20.0)	201 (27.7)
Body mass index, mean (SD)	31.72 (6.76)	26.96 (7.12)	22.58 (3.80)

Table 2. Distribution of Postoperative Outcomes by Procedure Type

	Reduction Mammoplasty (n = 2507)			Mastopexy (n = 380)			Augmentation Mammoplasty (n = 725)			P Value
	n	% Frequency	Median Day	n	% Frequency	Median Day	n	% Frequency	Median Day	
Median day of initial hospital discharge			1			0			0	
Morbidity										
Superficial SSI	72 _b	2.87	14.5	5 _{a,b}	1.32	13	5 _a	0.69	12	.001
Deep SSI	6 _a	0.24	21	1 _a	0.26	11	1 _a	0.14	15	.863
Organ space SSI	1 _a	0.04	21	0 _a	0.00	—	0 _a	—	—	.802
Wound disruption	23 _b	0.92	20	1 _{a,b}	0.26	23	0 _a	—	—	.017
Pneumonia	0	—	—	0	—	—	0	—	—	—
Unplanned reintubation	1 _a	0.04	1	0 _a	—	—	0 _a	—	—	.802
Pulmonary embolism	0	—	—	0	—	—	0	—	—	—
Ventilator >48 h	0	—	—	0	—	—	0	—	—	—
Progressive renal insufficiency	0	—	—	0	—	—	0	—	—	—
Acute renal failure	0	—	—	0	—	—	0	—	—	—
Urinary tract infection	4 _a	0.16	8	0 _a	—	—	3 _a	0.41	8	.259
Stroke/CVA	0 _a	—	—	0 _a	—	—	1 _a	0.14	2	.136
Coma >24 h	0	—	—	0	—	—	0	—	—	—
Cardiac arrest	0	—	—	0	—	—	0	—	—	—
Myocardial infarction	1 _a	0.04	1	0 _a	—	—	0 _a	—	—	.802
Bleeding requiring transfusions	5 _a	0.20	2	2 _a	0.53	2	0 _a	—	—	.167
Deep venous thrombosis	1 _a	0.04	4	0 _a	—	—	0 _a	—	—	.802
Sepsis	2 _a	0.08	6.5	0 _a	—	—	0 _a	—	—	.643
Septic shock	0	—	—	0	—	—	0	—	—	—
Graft/prosthesis/flap failure	3 _a	0.12	11	0 _a	—	—	0 _a	—	—	.516
Total complications reported ^a	112 _b	4.47	14	9 _{a,b}	2.37	11	9 _a	1.24	12	<.001
Reoperation	52 _b	2.07	—	6 _{a,b}	1.58	—	7 _a	0.97	—	.133
Mortality	0 _b	—	—	1 _a	0.26	13	0 _{a,b}	—	—	.014

Each subscript letter denotes a subset of categories whose column proportions do not differ significantly from each other. CVA, cerebral vascular accident; SSI, surgical site infection. Dashes were entered in cases in which there was insufficient data to make the appropriate calculations.

^aA single patient may have experienced more than 1 listed outcome.

Table 3. Association of Preoperative Variables With Postoperative Morbidity

	Reduction Mammoplasty (n = 2507)				Augmentation Mammoplasty (n = 725)				Mastopexy (n = 380)			
	Patients, No. (%)	Complications, No. (%)	Odds Ratio	P Value	Patients, No. (%)	Complications, No. (%)	Odds Ratio	P Value	Patients, No. (%)	Complications, No. (%)	Odds Ratio	P Value
Obesity	2156 (86.0)	103 (4.8)	1.54	.228	131 (18.1)	6 (4.6)	4.72	.041	209 (55.0)	6 (2.9)	1.555	.555
Smoking	300 (12.0)	17 (5.7)	1.31	.326	134 (18.5)	1 (0.7)	0.27	.308	49 (12.9)	3 (6.1)	4.656	.044
Diabetes	111 (4.4)	8 (7.2)	1.23	.611	11 (1.5)	1 (9.1)	3.10	.386	8 (2.1)	0 (0.0)	—	—
Chemotherapy	10 (0.4)	1 (10.0)	2.71	.351	1 (0.1)	0 (0.0)	—	—	11 (2.9)	1 (9.1)	4.554	.199
Dyspnea	70 (2.8)	8 (11.4)	2.37	.031	2 (0.3)	0 (0.0)	—	—	4 (1.1)	0 (0.0)	—	—
Hypertension	568 (22.7)	35 (6.2)	1.41	.157	36 (5.0)	3 (8.3)	2.40	.363	63 (16.6)	3 (4.8)	2.725	.525
Steroid use	23 (0.9)	2 (8.7)	1.79	.439	1 (0.1)	0 (0.0)	—	—	1 (0.3)	0 (0.0)	—	—
Age	—	—	1.00	.967	—	—	1.05	.192	—	—	1.017	.592
Operating time	—	—	1.00	.026	—	—	1.01	.003	—	—	1.002	.636

DISCUSSION

This study evaluates the 30-day morbidity profiles and risk factors of 3 elective breast surgical procedures: augmentation mammoplasty, reduction mammoplasty, and mastopexy. In general, these procedures are well tolerated by patients with overall complication rates lower than 5% for each of the 3 procedures. This is less than the complication rate suggested by the literature, with previous single-surgeon or institutional studies reporting a range of overall morbidity rates from 2% to 53% for reduction procedures,^{2,13} 5% to 38% for augmentation operations,^{14,19} and 2% to 52% for mastopexy^{20,23} (Table 4).

Existing studies are cited to provide a reference point for overall morbidity from these procedures, although a direct comparison of these results is difficult due to the focus on short-term outcomes by the NSQIP registry. Comparison data used in this study were found by searching the MEDLINE catalogue using PubMed. We included studies published within the past 15 years that focused on the outcomes of these single procedures and that reported complication information in sufficient detail. Studies attempting to validate new techniques or devices were excluded. We further restricted our analysis to studies that had a minimum of 100 patients for reduction and mastopexy procedures and 500 for augmentation procedures. The differences in observed complication rates in the literature are likely due to several factors. In particular, the severity and significance of complications reported varied dramatically between studies; some studies reported only severe complications that required intervention, whereas others included relatively minor adverse events such as changes in nipple sensation.^{4,10,13} It is also important to note that the length of follow-up will affect the number of

complications reported; the emphasis of the NSQIP registry is on short-term perioperative morbidity and risk factors, whereas many studies in the literature have extended follow-ups. Additional factors that influence the reporting of outcomes include the operating surgeon, implant type, and surgical technique. With such a large discrepancy in reported complication rates and a host of contributing factors, it can be difficult to extrapolate the results of these studies into practice. A more standardized approach to record and report plastic surgery-specific outcomes may yield more reliable data that can better inform prospective patients.

In the present study, 30-day morbidity and mortality rates were generally low for all procedures. However, reduction mammoplasty patients experienced marginally higher instances of overall morbidity (4.47%), superficial SSI (2.87%), and wound disruptions (0.92%) compared with mastopexy and augmentation patients. Although it is difficult to compare 3 different surgical procedures that, by nature, entail different risks, the differences in complication rates are likely due to the more extensive nature of reduction mammoplasties. In general, reduction mammoplasties entail more dissection and larger skin flaps than the other 2 procedures that were evaluated, which could lead to increased complication rates. Furthermore, the reduction mammoplasty cohort had a higher average BMI than the other groups studied, which has been documented to independently confer an additional risk of complications.^{25,30,33-35} The volume of reduction may also be a significant factor in the development of adverse outcomes; however, this information was not captured by this database.

In the context of low overall morbidity, rates of life-threatening complications were extremely low, with rates

Table 4. Comparison of Reported Complication Rates by a Single Surgeon or Institution

Rate	n	Lead Author/Citation
Reduction		
2%	117	Moskovitz ²
11%	371	Mandrekas ⁴
14%	444	Stevens ⁵
18%	153	Gulcelik ⁷
20%	363	Schnur ⁸
22%	799	Menke ⁹
22%	338	Buenaventura ¹⁰
23%	518	Scott ¹¹
53%	406	Davis ¹³
21%		Mean
4%	2779	Present study
Augmentation		
5%	3002	Araco ¹⁴
16%	1682	Huang ¹⁵
21%	812	Codner ¹⁶
23%	690	Tebbetts ¹⁷
24%	749	Gabriel ¹⁸
38%	619	Stutman ¹⁹
21%		Mean
1%	839	Present study
Mastopexy		
2%	124	Flowers ²⁰
9%	150	Stevens ²¹
21%	205	Caldeira ²²
52%	108	Rubin ²³
21%		Mean
2%	654	Present study

of 0.00%, 0.16%, and 0.00% for mastopexy, reduction, and augmentation patients, respectively, validating the safety of these common elective breast procedures. In addition, 30-day reoperation rates were low for all procedure types, with mastopexy, reduction, and augmentation patients experiencing rates of 1.58%, 2.07%, and 0.97%, respectively, although the circumstances of reoperation were not captured by the NSQIP database. Prospective studies that record these details would improve our

Table 5. Reduction Complication Rates From Multi-Institutional Studies

	Cunningham et al ³⁶ (BRAVO)	Hanemann and Grotting ²⁵ (CosmetAssure)	Present Study (NSQIP)
No. patients	179	904	2507
Wound infection, %	1.2	0.4	3.2
DVT/PE, %	—	—	<0.1
Reoperation, %	—	—	2.1
Overall morbidity, %	43.0	1.8	4.5

BRAVO, Breast Reduction Assessment: Values and Outcomes; DVT, deep venous thrombosis; NSQIP, National Surgical Quality Improvement Program; PE, pulmonary embolism.

knowledge of reoperation and would also allow for improved patient counseling. With respect to the existing literature, observed reoperation rates in this analysis are relatively low, with a wide range of reported rates from 1.6% to 19.1%.^{14,16,23,36} Similar to complication rates, discrepancies in reported reoperation rates may also be attributed to differences in surgeon, surgical technique, implant type, and follow-up length, all of which make it difficult to arrive at firm conclusions without additional comparative analysis.

Logistic modeling identified several comorbidities that were associated with an increased incidence of morbidity (Table 3). Patients with a BMI > 25 were at an increased risk of complications in the augmentation cohort, which has been well documented in past studies.^{25,30,33-35} Smoking was observed to confer an added risk of complications in the mastopexy cohort, which is in agreement with previous studies. It should be noted, however, that only a relatively small number of patients presented with some of these preoperative factors, which may limit the generalizability of these results. The length of surgery was also found to be associated with increased complications in both reduction and augmentation patients. Prior radiation treatment, which has been linked to adverse outcomes in previous cancer-based breast surgery studies, was not included in the regression models due to the low number of patients presenting with prior radiation.^{30,37} This was undoubtedly due to the strict constraints on the timing of radiation prior to elective breast surgery by the NSQIP data collection protocols, which only capture radiotherapy occurring within 90 days prior to the operation and therefore limit the number of patients defined as having a positive history of radiation. In addition, NSQIP does not record the location of radiation, which would be useful for more in-depth analysis.

As mentioned previously, limited multi-institutional data assess the outcomes of cosmetic operations. Using TOPS data, Alderman et al²⁴ described an overall morbidity of 0.9% for augmentation mammoplasty procedures. This is slightly lower than the 1.24% found in this study

Table 6. Augmentation Complication Rates From Multi-Institutional Studies

	Alderman et al ²⁴ (TOPS)	Alderman et al ²⁴ (CosmetAssure)	Hanemann and Grotting ²⁵ (CosmetAssure)	Henriksen et al ³⁹ (DPB)	Hvilsom et al ⁴⁰ (DPB)	Present Study (NSQIP)
No. patients	7310	3350	8929	1090	5373	725
Wound infection, %	0.3	0.1	0.2	0.9	1.5	0.8
DVT/PE, %	0.2	<0.01	—	—	—	0.0
Reoperation, %	—	—	—	24.2	4.8	1.0
Overall morbidity, %	0.9	0.8	1.7	26.3	16.7	1.2

DPB, Danish Registry for Plastic Surgery of the Breast; DVT, deep venous thrombosis; NSQIP, National Surgical Quality Improvement Program; PE, pulmonary embolism; TOPS, Tracking Operations and Outcomes for Plastic Surgeons.

Table 7. Mastopexy Complication Rates From Multi-Institutional Studies

	Hanemann et al ²⁵ (CosmetAssure)	Present Study (NSQIP)
No. patients	1250	380
Wound infection, %	0.2	1.6
DVT/PE, %	—	0.0
Reoperation, %	—	1.6
Overall morbidity, %	1.8	2.4

DVT, deep venous thrombosis; NSQIP, National Surgical Quality Improvement Program; PE, pulmonary embolism.

(Tables 5-7), which could be due to the lower infection rate observed in the TOPS study as compared with the NSQIP data (0.3% vs 0.8%). Both of these observed rates suggest that augmentation mammoplasty procedures are well tolerated by patients. An additional multi-institutional study of reduction mammoplasty procedures, the Breast Reduction Assessment: Values and Outcomes (BRAVO) study, evaluated data from a multicentered, controlled evaluation of breast reduction complications. Data were prospectively collected for 15 months from 14 sites. The BRAVO study revealed an overall complication rate of 43%, which is dramatically higher than that reported from the NSQIP data (Tables 5-7). This may be due to the small sample size ($n = 179$) and inconsistent definitions and reporting of complications.³⁸

In 1999, the Danish Registry for Plastic Surgery of the Breast (DPB) was established, marking the first nationwide prospective database that captures an array of cosmetic plastic surgery procedures. Data in the DPB are collected in a similar manner to the NSQIP data.^{39,40} Compared with the results of this present study, analyses of the DPB have reported significantly higher rates of complications (Table 6), possibly due to the extended follow-up length (follow-up ranged from 0.1-8.7 years) and the design of the study, which included specific breast complications such as change in sensation and capsular

contracture.^{39,40} The NSQIP program was designed for multiple surgical specialties and therefore does not record all germane complications of breast procedures.

Use of the NSQIP database imparts a myriad of strengths to this study, including a large study population, validated and risk-adjusted data with standardized definitions, and reporting from over 200 medical institutions across the United States. In addition, these data are reliable and unbiased, with the fidelity of the data set having been previously tested.²⁸ Moreover, the data used in this study were derived from both inpatient and outpatient hospital settings, providing a perspective broad enough to incorporate many plastic surgery procedures. Using these data, we were able to analyze the short-term surgical complications for elective breast surgery, allowing for thorough evaluation of outcomes in the early postoperative period.

The main limitations of this study are the lack of procedure-specific outcomes reported by the NSQIP registry and the short length of follow-up. As a result, there may be an underreporting of complications in this study. Previous literature has suggested that plastic surgery-specific complications, such as capsular contracture, could be captured in future iterations of the registry.³⁰ These factors are not captured in this database and, along with cosmetic outcomes and patient satisfaction, should be studied in future efforts. In addition, a restructuring of the registry to increase its capture period from 30 days after the index operation to 90 days or even 1 year has been proposed, as many complications from plastic surgery can occur outside of the 30-day period.³⁰ These additions would allow for examination of longer-term outcomes that would increase the utility of NSQIP.

CONCLUSIONS

The prospective NSQIP database affords the ability to objectively track short-term morbidity, mortality, and reoperation rates of elective breast surgical procedures in both the inpatient and outpatient hospital environment. Extremely low mortality and morbidity rates—particularly life-threatening morbidities—validate the safety of these procedures when

performed in a hospital setting. Information garnered from the NSQIP data will be useful for informing patients and improving outcomes in our field.

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REFERENCES

1. American Society for Aesthetic Plastic Surgery. 2011 Cosmetic Surgery National Data Bank Statistics. <http://www.surgery.org/media/statistics>
2. Moskovitz MJ, Muskin E, Baxt SA. Outcome study in liposuction breast reduction. *Plast Reconstr Surg*. 2004;114(1):55-60, discussion 61.
3. Cruz-Korchin N, Korchin L. Vertical versus Wise pattern breast reduction: patient satisfaction, revision rates, and complications. *Plast Reconstr Surg*. 2003;112(6):1573-1578, discussion 1579-1581.
4. Mandrekas AD, Zambacos GJ, Anastasopoulos A, Hapsas DA. Reduction mammoplasty with the inferior pedicle technique: early and late complications in 371 patients. *Br J Plast Surg*. 1996;49(7):442-446.
5. Stevens WG, Gear AJ, Stoker DA, et al. Outpatient reduction mammoplasty: an eleven-year experience. *Aesthetic Surg J*. 2008;28(2):171-179.
6. Hofmann AK, Wuestner-Hofmann MC, Bassetto F, Scarpa C, Mazzoleni F. Breast reduction: modified "Lejour technique" in 500 large breasts. *Plast Reconstr Surg*. 2007;120(5):1095-1104, discussion 1105-1107.
7. 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(6):395-399.
8. Schnur PL, Schnur DP, Petty PM, Hanson TJ, Weaver AL. Reduction mammoplasty: an outcome study. *Plast Reconstr Surg*. 1997;100(4):875-883.
9. Menke H, Eisenmann-Klein M, Olbrisch RR, Exner K. Continuous quality management of breast hypertrophy by the German Association of Plastic Surgeons: a preliminary report. *Ann Plast Surg*. 2001;46(6):594-598, discussion 598-600.
10. Buenaventura S, Severinac R, Mullis W, Beasley M, Jacobs W, Wood D. Outpatient reduction mammoplasty: a review of 338 consecutive cases. *Ann Plast Surg*. 1996;36(2):162-166.
11. Scott GR, Carson CL, Borah GL. Maximizing outcomes in breast reduction surgery: a review of 518 consecutive patients. *Plast Reconstr Surg*. 2005;116(6):1633-1639, discussion 1640-1641.
12. Zoumaras J, Lawrence J. Inverted-T versus vertical scar breast reduction: one surgeon's 5-year experience with consecutive patients. *Aesthetic Surg J*. 2008;28(5):521-526, discussion 526-527.
13. Davis GM, Ringler SL, Short K, Sherrick D, Bengtson BP. Reduction mammoplasty: long-term efficacy, morbidity, and patient satisfaction. *Plast Reconstr Surg*. 1995;96(5):1106-1110.
14. Araco A, Gravante G, Araco F, Delogu D, Cervelli V, Walgenbach K. A retrospective analysis of 3,000 primary aesthetic breast augmentations: postoperative complications and associated factors. *Aesthetic Plast Surg*. 2007;31(5):532-539.
15. Huang GJ, Wichmann JL, Mills DC. Transaxillary subpectoral augmentation mammoplasty: a single surgeon's 20-year experience. *Aesthetic Surg J*. 2011;31(7):781-801.
16. Codner MA, Mejia JD, Locke MB, et al. A 15-year experience with primary breast augmentation. *Plast Reconstr Surg*. 2011;127(3):1300-1310.
17. Tebbetts JB. Axillary endoscopic breast augmentation: processes derived from a 28-year experience to optimize outcomes. *Plast Reconstr Surg*. 2006;118(7)(suppl):53S-80S.
18. Gabriel SE, Woods JE, O'Fallon WM, Beard CM, Kurland LT, Melton LJ III. Complications leading to surgery after breast implantation. *N Engl J Med*. 1997;336(10):677-682.
19. Stutman RL, Codner M, Mahoney A, Amei A. Comparison of breast augmentation incisions and common complications. *Aesthetic Plast Surg*. 2012;36(5):1096-1104.
20. Flowers RS, Smith EM Jr. "Flip-flap" mastopexy. *Aesthetic Plast Surg*. 1998;22(6):425-429.
21. Stevens WG, Stoker DA, Freeman ME, Quardt SM, Hirsch EM. Mastopexy revisited: a review of 150 consecutive cases for complication and revision rates. *Aesthetic Surg J*. 2007;27(2):150-154.
22. Caldeira AM, Lucas A, Grigalek G. Mastoplasty: the triple-flap interposition technique. *Aesthetic Plast Surg*. 1999;23(1):51-60.
23. Rubin JP, Gusenoff JA, Coon D. Dermal suspension and parenchymal reshaping mastopexy after massive weight loss: statistical analysis with concomitant procedures from a prospective registry. *Plast Reconstr Surg*. 2009;123(3):782-789.
24. Alderman AK, Collins ED, Streu R, et al. Benchmarking outcomes in plastic surgery: national complication rates for abdominoplasty and breast augmentation. *Plast Reconstr Surg*. 2009;124(6):2127-2133.
25. Hanemann MS Jr, Grotting JC. Evaluation of preoperative risk factors and complication rates in cosmetic breast surgery. *Ann Plast Surg*. 2010;64(5):537-540.
26. Hall BL, Hamilton BH, Richards K, Bilimoria KY, Cohen ME, Ko CY. Does surgical quality improve in the American College of Surgeons National Surgical Quality Improvement Program? An evaluation of all participating hospitals. *Ann Surg*. 2009;250(3):363-376.

27. Khuri SF. The NSQIP: a new frontier in surgery. *Surgery*. 2005;138(5):837-843.
28. Khuri SF, Daley J, Henderson W, et al. The Department of Veterans Affairs' NSQIP: the first national, validated, outcome-based, risk-adjusted, and peer-controlled program for the measurement and enhancement of the quality of surgical care. National VA Surgical Quality Improvement Program. *Ann Surg*. 1998;228(4):491-507.
29. Khuri SF, Henderson WG, Daley J, et al. Successful implementation of the Department of Veterans Affairs' National Surgical Quality Improvement Program in the private sector: the Patient Safety in Surgery study. *Ann Surg*. 2008;248(2):329-336.
30. Ogunleye AA, de Blacam C, Curtis MS, Colakoglu S, Tobias AM, Lee BT. An analysis of delayed breast reconstruction outcomes as recorded in the American College of Surgeons National Surgical Quality Improvement Program. *J Plast Reconstr Aesthetic Surg*. 2012;65(3):289-294.
31. Birkmeyer JD, Shahian DM, Dimick JB, et al. Blueprint for a new American College of Surgeons: National Surgical Quality Improvement Program. *J Am Coll Surg*. 2008;207(5):777-782.
32. American College of Surgeons. *American College of Surgeons National Surgical Quality Improvement Program User Guide*. Chicago, IL: American College of Surgeons; 2008.
33. Shah R, Al-Ajam Y, Stott D, Kang N. Obesity in mammoplasty: a study of complications following breast reduction. *J Plast Reconstr Aesthetic Surg*. 2011;64(4):508-514.
34. Chun YS, Schwartz MA, Gu X, Lipsitz SR, Carty MJ. Body mass index as a predictor of postoperative complications in reduction mammoplasty. *Plast Reconstr Surg*. 2012;129(2):228e-233e.
35. Chen CL, Shore AD, Johns R, Clark JM, Manahan M, Makary MA. The impact of obesity on breast surgery complications. *Plast Reconstr Surg*. 2011;128(5):395e-402e.
36. McCafferty LR, Casas LA, Stinnett SS, Lin S, Rho J, Skiles M. Multisite analysis of 177 consecutive primary breast augmentations: predictors for reoperation. *Aesthetic Surg J*. 2009;29(3):213-220.
37. Selber JC, Kurichi JE, Vega SJ, Sonnad SS, Serletti JM. Risk factors and complications in free TRAM flap breast reconstruction. *Ann Plast Surg*. 2006;56(5):492-497.
38. Cunningham BL, Gear AJ, Kerrigan CL, Collins ED. Analysis of breast reduction complications derived from the BRAVO study. *Plast Reconstr Surg*. 2005;115(6):1597-1604.
39. Henriksen TF, Holmich LR, Fryzek JP, et al. Incidence and severity of short-term complications after breast augmentation: results from a nationwide breast implant registry. *Ann Plast Surg*. 2003;51(6):531-539.
40. Hvilsum GB, Holmich LR, Henriksen TF, Lipworth L, McLaughlin JK, Friis S. Local complications after cosmetic breast augmentation: results from the Danish Registry for Plastic Surgery of the breast. *Plast Reconstr Surg*. 2009;124(3):919-925.