Autologous Options for Postmastectomy Breast Reconstruction: A Comparison of Outcomes Based on the American College of Surgeons National Surgical Quality Improvement Program

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BACKGROUND: The postmastectomy patient faces a plethora of choices when opting for autologous breast reconstruction; however, multi-institutional data comparing the available techniques are lacking. The National Surgical Quality Improvement Program (NSQIP) database provides a robust patient cohort for comparing outcomes and determining independent predictors of complications for each autologous method.

STUDY DESIGN: The NSQIP database was retrospectively reviewed from 2006 to 2010, identifying 3,296 autologous breast reconstruction patients. Univariate analyses compared complication and reoperation rates. Multivariable logistic regression analyses of 4 cohorts (free flaps, pedicled transverse rectus abdominis myocutaeous (TRAM) flaps, latissimus, and all flaps in aggregate) determined complication rates and independent risk factors for complications and specific outcomes of interest (surgical site infection [SSI], flap failure, reoperation) in all flap types.

RESULTS: American Society of Anesthesiologists (ASA) classification ≥ 3, body mass index > 30 kg/m^2, recent surgery, delayed reconstruction, and prolonged operative times are significant predictors of increased complications in autologous reconstructions. Rates of complications, flap failure, and reoperation were highest in the free tissue transfer group ($p < 0.001$). Latissimus flaps showed significantly lower rates of complications than other autologous methods ($p < 0.001$). Pedicled TRAM patients had the highest incidences of venous thromboembolic disease and SSI.

CONCLUSIONS: This large-scale, multicenter evaluation of outcomes in autologous breast reconstruction found that free flaps have the highest captured 30-day complication and reoperation rates of any autologous reconstructive method; complications in latissimus flaps were surprisingly few. Pedicled TRAM and latissimus flaps remain the most commonly used autologous reconstructive methods. In addition to providing statistically robust outcomes data, this study contributes significantly to patient education and preoperative planning discussions. (J Am Coll Surg 2013;216:229–238. © 2013 by the American College of Surgeons)

The most recent data from the American Cancer Society estimate that, in 2011, more than 230,000 new cases of breast cancer were diagnosed in the United States.[1,2] As the number of options for breast reconstruction after mastectomy has increased, there has been a concomitant increase in the number of women who choose to undergo mastectomy and prophylactic bilateral mastectomy for surgical management of primary breast cancers.[3]

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Dr Gart and Mr Smetona contributed equally to this work.

Ethical approval: Deidentified patient information is freely available to all institutional members who comply with the ACS-NSQIP Data Use Agreement. The Data Use Agreement implements the protections afforded by the Health Insurance Portability and Accountability Act of 1996 and the ACS-NSQIP Hospital Participation Agreement.

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Abbreviations and Acronyms

BMI = body mass index
DVT = deep vein thrombosis
NSQIP = National Surgical Quality Improvement Program
PE = pulmonary embolism
TRAM = transverse rectus abdominis myocutaneous
SSI = surgical site infection

The reasons behind this paradigm shift are manifold, but much can be attributed to refined reconstructive techniques and patient desires to minimize recurrence risks and avoid lifelong intensive breast surveillance.

Available options for breast reconstruction can be broadly classified as expander/implant- or autologous tissue-based methods. Although expander/implant-based methods constitute the majority of breast reconstructions performed in the United States,[4] there remain several instances in which autologous tissue is preferred, including in patients with a history of external-beam radiation therapy, previous failed implant-based reconstructions, chest wall involvement, or other circumstances in which the native tissues are deemed incapable of accommodating a prosthesis and subsequent expansion.[5,6] Moreover, many patients prefer autologous tissue-based reconstructions for their more "realistic" feel and aesthetic advantages, including more natural aging, ptosis, and responsiveness to changes in body weight.[4,5,7-11]

In these instances, choosing which of the myriad autologous tissue-based techniques will provide a given patient with the best result and fewest overall complications has been a matter of significant debate. Currently, the available literature comparing various autologous methods is not comprehensive and presents highly variable results.[8,10,12-26] Moreover, existing large series are often selected from institutions with particular flap preferences based on previous success and failure rates, skewing outcomes data and making direct comparisons difficult.

From 2006 to 2010, the National Surgical Quality Improvement Program (NSQIP) surveyed more than 240 participating hospitals across the country and recorded more than 1.3 million surgical procedures. Trained nurses collected information in a uniform fashion to produce standardized, unbiased data.[27,28] The NSQIP tracks 136 variables describing demographic data, patient comorbidities, operative details, and postoperative complications. This standardized recording provides the opportunity to make direct comparisons between autologous methods and develop multivariable logistic regression models to determine independent predictors of outcomes in distinct flap cohorts. This study presents the results of a comparative analysis of outcomes and risk factors for 30-day postoperative complications in a series of nearly 3,300 autologous breast reconstruction patients pooled from the NSQIP database.

METHODS

The NSQIP is a nationally validated, risk-adjusted, surgical outcomes database, aimed at measuring and improving the quality of care delivered to surgical patients throughout the United States. The NSQIP database was retrospectively reviewed to obtain data on all patients undergoing autologous tissue-based breast reconstruction between 2006 and 2010 at more than 240 participating institutions across the United States.

Primary endpoints tracked by NSQIP include complications, reoperation rates, and mortalities. As defined by the NSQIP, complications include those at the surgical site (superficial, deep, or organ-space surgical site infection infection [SSI]; wound disruption; graft, prosthesis, or flap failure); hematologic (transfusion rates; deep vein thrombosis [DVT] or pulmonary embolism [PE]); respiratory (unplanned intubation, pneumonia, patient requiring mechanical ventilation for more than 48 hours), cardiovascular (myocardial infarction, cardiac arrest), genitourinary (renal insufficiency, acute renal failure, urinary tract infection), neurologic (cerebrovascular accident [CVA], peripheral neurologic deficit, coma lasting more than 24 hours), and multisystem (sepsis or septic shock) complications. Reoperation is defined as return to the operating room within 30 days of the original procedure. All deaths, regardless of cause, which occurred within 30 days of the original surgical procedure, are included as mortalities.

Patients were identified by Current Procedural Terminology (CPT) code as follows: free flap breast reconstruction (CPT 19364), latissimus dorsi flap breast reconstruction (CPT 19361), and pedicled transverse rectus abdominis myocutaneous (TRAM) flap breast reconstruction (CPT 19367-9). Because NSQIP does not attribute complications to a particular flap or breast in bilateral reconstructions, patients with more than 1 reconstructive type were excluded. Bilateral reconstructions were identified as patients with 2 identical reconstructive codes; immediate reconstructions were those occurring in conjunction with mastectomy. Patients undergoing latissimus flap reconstruction with ipsilateral breast prosthesis (tissue expander or implant) were included in the latissimus flap cohort. Development of the cohort is summarized in Figure 1.

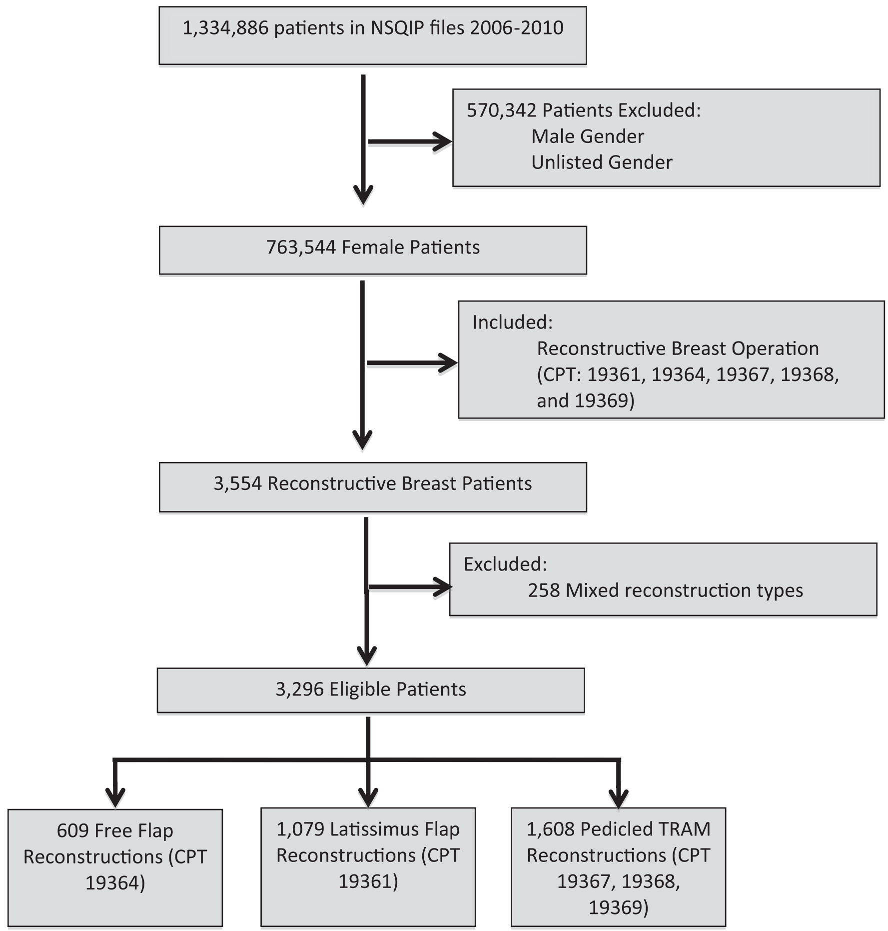

Figure 1. Study attrition diagram. NSQIP, National Surgical Quality Improvement Program; TRAM, transverse rectus abdominis myocutaneous.

Statistical analysis

All statistical analyses were performed using SPSS version 20.0 (IBM Corp). For bivariate analyses, categorical variables were compared using the chi-square test, and analysis of variance (ANOVA) was used for continuous variables. We conducted a series of multivariable logistic regression analyses within each reconstructive method (free flaps, latissimus flaps, pedicle TRAM flaps) to determine the independent risk factors of postoperative complications for each patient cohort. For each analysis, preoperative variables (patient demographics and comorbidities) showing an association with postoperative complications at $p < 0.2$ in the univariate analysis were entered into a backwards stepwise regression with exit criteria of $p < 0.05$. The resulting variables were included in the logistic regression models. Variables with fewer than 10 events were excluded from logistic regression models.[29,30] Using a similar method, we also conducted a multivariable logistic regression with all patients combined to compare the complications among the 3 reconstructive methods (free flaps, latissimus dorsi flaps, and pedicled TRAM flaps).

In order to control for the effects of delayed breast reconstruction, operative times, and bilateral procedures on complication rates, these variables were included in all logistic regression models. In order to control for any concurrent surgical procedures, total relative value units (RVUs) were used as a proxy for additional surgical complexity.[31,32]

In a similar fashion, multivariable analysis was carried out on all flap types to determine independent predictors for complications of interest (flap failure, SSI, and reoperation), as well as overall complications. In order to control for the effect of reconstructive method on the rates of overall complications, flap type was included in the regression model for total complications. For all logistic regression models, Hosmer-Lemeshow (H-L) and C-statistic values were calculated to assess the calibration and discrimination of the overall goodness of model fit.[33-35]

Table 1. Characterization of the Study Population by Reconstruction Type

Characteristic	Free flap (n = 609)	Latissimus flap (n = 1,079)	Pedicle TRAM (n = 1,608)	p Value
Age, y (SD)	50.7 (9.3)*	52.4 (10.8)†	51.8 (9.0)†	0.003
Body mass index (SD)	29.0 (5.5)*	27.6 (6.2)†	28.7 (6.2)*	<0.001
Race, %				0.300
Asian	3.8*	2.5*	2.9*	
African American	13.0*	11.0*	10.2*	
Other	7.9*	9.4*	9.8*	
White	75.4*	77.1*	77.1*	
Diabetes, n (%)	39 (6.4)*	62 (5.7)*†	70 (4.4)†	0.091
Smokers, n (%)	55 (9.0)*	144 (13.3)†	163 (10.1)*	0.008
Radiation therapy, n (%)	7 (1.1)*	11 (1.0)*	9 (0.6)*	0.261
Chemotherapy, n (%)	35 (5.7)*	52 (4.8)*	72 (4.5)*	0.461

*Columns are significantly different from one another at $p < 0.05$.
†Columns do not differ significantly.
TRAM, transverse rectus abdominis myocutaneous.

RESULTS

A total of 3,296 patients were included in the study (Fig. 1). Patient demographic and flap distribution data are shown in Table 1. Significant differences among groups were noted in age, mean BMI, and number of active smokers at the time of surgery. Free flap reconstructions constituted 18.5% of all autologous reconstructions in this series; pedicled TRAM (48.8%) and latissimus flaps (32.7%) represented a majority (81.5%) of reconstructive operations (Fig. 2).

Comparison of outcomes between flap types

Outcomes grouped by reconstructive method are shown in Table 2. Statistically significant differences among groups were noted in overall complication rates; reoperation rates; flap complications, including SSI and flap failure rates; and nonflap complications, including deep vein thrombosis (DVT), pulmonary embolism (PE), and blood transfusion requirements. The incidence of all complications (overall, flap-related, and nonflap-related), reoperation, perioperative blood transfusion, and flap failure were highest in the free tissue transfer group. The lowest rates of complications, SSIs, and flap failure were found in the latissimus cohort. The pedicled TRAM patients had the highest incidence of both DVT and PE. All of these results reached a level of statistical significance at $p < 0.05$.

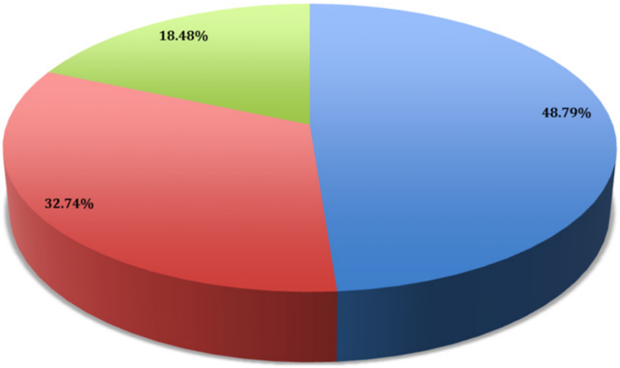

Figure 2. Relative use of autologous reconstructive techniques. Blue, pedicled transverse rectus abdominis myocutaneous (TRAM) flaps; red, latissimus flaps; green, free flaps.

Multivariate logistic regression analysis

Predictors of complications

Multivariate logistic regression analysis was used to determine independent predictors of overall complications in each cohort: pedicled TRAM flaps, latissimus dorsi flaps, and free flaps (Table 3). Hosmer-Lemeshow test and C-statistic values indicated good fit and acceptable discriminatory ability of all regression models.

Independent predictors of complications are summarized in Table 3. Obesity and prolonged operating times were both independent predictors of complications in free tissue transfer breast reconstruction. Higher American Society of Anesthesiologists (ASA) classification, delayed reconstruction, and prolonged operative time independently predicted postoperative complications in latissimus dorsi flap breast reconstruction. Complications after pedicled TRAM flap breast reconstruction were independently associated with ASA class 3-4, obesity, diabetes mellitus, previous operation within 30 days, delayed reconstruction, and increasing operative time.

Risk of specific outcomes

Multivariate logistic regression was used to compute adjusted odds ratios (OR) for specific outcomes of interest to the reconstructive surgeon, including overall

Table 2. Summary of Outcomes by Reconstructive Type

Outcome	Free flaps (n = 609) n	%	Latissimus flaps (n = 1,079) n	%	Pedicle TRAM flaps (n = 1,608) n	%	p Value
Overall complications	118*	19.4	77†	7.1	216‡	13.4	<0.001
Reoperation	95*	15.6	62†	5.7	159‡	9.9	<0.001
Flap complications	73*	12.0	54†	5.0	160*	10.0	<0.001
Wound infection	36*	5.9	36†	3.3	108*	6.7	0.001
Superficial SSI	17*†	2.8	17†	1.6	63*	3.9	0.002
Deep SSI	16*	2.6	9†	0.8	40*	2.5	0.005
Organ/space SSI	5*†	0.8	11†	1.0	6*	0.4	0.115
Graft/flap failure	35*	5.7	14†	1.3	54‡	3.4	<0.001
Wound disruption	12*	2.0	7†	0.6	22*†	1.4	0.052
Nonflap complications	69*	11.3	34†	3.2	92‡	5.7	<0.001
Pneumonia	4*	0.7	1†	0.1	6*†	0.4	0.144
Unplanned intubation	1*	0.2	3*	0.3	2*	0.1	0.653
Pulmonary embolism	1*†	0.2	1†	0.1	15*	0.9	0.005
Ventilator > 48 h	0*	0.0	1*	0.1	2*	0.1	0.687
Renal insufficiency	0*	0.0	0*	0.0	1*	0.1	0.592
Acute renal failure	0*	0.0	0*	0.0	2*	0.1	0.350
Urinary tract infection	9*	1.5	6*	0.6	10*	0.6	0.075
Coma	0	0.0	0	0.0	0	0.0	NA
Stroke	0	0.0	0	0.0	0	0.0	NA
Peripheral neurologic deficit	1*	0.2	0*	0.0	2*	0.1	0.463
Cardiac arrest	1*	0.2	0*	0.0	0*	0.0	0.110
Myocardial infarction	1*	0.2	0*	0.0	1*	0.1	0.421
Blood transfusion	47*	7.7	17†	1.6	31†	1.9	<0.001
Deep vein thrombosis	2*†	0.3	2†	0.2	16*	1.0	0.019
Sepsis/septic shock	6*†	1.0	7†	0.6	24*	1.5	0.118

*Columns are significantly different from one another at $p < 0.05$.
†Columns do not differ significantly.
‡Column significantly different from the other two at $p < 0.05$.
SSI, surgical site infection; TRAM, transverse rectus abdominis myocutaneous.

complications, SSI, flap failure, and reoperation rates (Table 4). Compared with latissimus flaps (OR = 1.000), both pedicled TRAM and free flaps had higher rates of all individual complications. Free flap autologous breast reconstructions showed the highest rates of flap failure (OR = 2.409) and reoperation (OR = 2.025); pedicled

Table 3. Independent Risk Factors of Postoperative Complications by Reconstructive Type

Variables	Free flaps OR	95% CI	p Value	Latissimus flaps OR	95% CI	p Value	Pedicle TRAM flaps OR	95% CI	p Value
ASA classification (3-4 vs 1-2)	*	*	*	2.585	1.592−4.198	<0.0001	1.516	1.064−2.158	0.021
Obesity (BMI ≥ 30 kg/m²)	1.863	1.222−2.838	0.004	*	*	*	1.785	1.314−2.426	<0.0001
Diabetes	*	*	*	*	*	*	2.401	1.379−4.181	0.002
Prior operation (<30 d)	*	*	*	*	*	*	3.792	2.337−6.152	<0.0001
Delayed reconstruction	1.124	0.589−2.146	0.723	2.556	1.343−4.867	0.004	1.994	1.244−3.195	0.004
Bilateral reconstruction	1.073	0.621−1.853	0.801	0.723	0.335−1.561	0.409	0.794	0.497−1.268	0.334
Other RVUs	0.989	0.970−1.008	0.256	1.010	0.988−1.033	0.369	1.013	0.998−1.029	0.095
Operating time	1.002	1.001−1.003	<0.0001	1.004	1.002−1.005	<0.0001	1.001	1.000−1.002	0.011
Hosmer-Lemeshow test			0.552			0.766			0.596
C-statistic			0.669			0.693			0.678

*This variable did not qualify for entry to the regression model based on the described methods.
ASA, American Society of Anesthesiologists; BMI, body mass index; OR, odds ratio; RVU, relative value unit; TRAM, transverse rectus abdominis myocutaneous.

Table 4. Multivariate Regression Analysis of Total Complications, Surgical Site Infection, Flap Failure, and Reoperation for All Breast Reconstruction Patients

	Total Complications			Surgical Site Infection			Flap Failure			Reoperation		
		95% CI			95% CI			95% CI			95% CI	
Predictive variable	**OR**	**Lower**	**Upper**	**OR**	**Lower**	**Upper**	**OR**	**Lower**	**Upper**	**OR**	**Lower**	**Upper**
Flap type												
Latissimus (ref)	1.000			1.000			1.000			1.000		
Free flap	1.909	1.349	2.702	1.742	1.030	2.945	2.409	1.209	4.803	2.025	1.387	2.956
Pedicled TRAM	1.923	1.450	2.549	2.207	1.489	3.270	2.186	1.198	3.991	1.706	1.250	2.330
ASA Classification	1.741	1.369	2.215	*	*	*	*	*	*	1.646	1.262	2.148
Diabetes	*	*	*	2.528	1.544	4.142	*	*	*	*	*	*
Obesity (BMI > 30 kg/m^2)	1.703	1.368	2.120	1.730	1.263	2.370	1.547	1.032	2.318	1.413	1.107	1.804
Prior operation	2.630	1.741	3.971	*	*	*	3.695	1.978	6.905	2.076	1.303	3.308
Smoking	*	*	*	1.686	1.107	2.568	*	*	*	*	*	*
Delayed procedure	1.714	1.237	2.373	1.609	1.017	2.547	1.094	0.578	2.073	1.258	0.870	1.818
Bilateral procedure	0.855	0.620	1.178	1.243	0.787	1.963	0.919	0.517	1.635	0.946	0.665	1.344
Operating time	1.002	1.001	1.002	1.000	0.999	1.001	1.002	1.001	1.003	1.002	1.001	1.002
Sum RVUs	1.005	0.994	1.016	0.997	0.982	1.013	0.998	0.978	1.018	0.998	0.986	1.010
Hosmer-Lemeshow test	0.912			0.319			0.848			0.553		
C-statistic	0.694			0.655			0.699			0.663		

*This variable did not qualify for entry to the regression model based upon the described methods.
ASA, American Society of Anesthesiologists; BMI, body mass index; OR, odds ratio; RVU, relative value unit; TRAM, transverse rectus abdominis myocutaneous.

TRAM flaps showed the highest rates of SSI (OR = 2.207). After adjusting for flap type, pedicled TRAM flaps showed the highest rates of overall complications (OR = 1.923).

Finally, regression models were used to compute adjusted expected values of outcomes for all flaps (Fig. 3). After adjustment for risk factors, latissimus flaps again showed the lowest expected rate of complications, reoperation, flap failure, and SSI.

DISCUSSION

Flap utilization

In 1977, Schneider and colleagues[36] introduced the latissimus dorsi myocutaneous island flap for breast reconstruction. Despite the numerous advantages of this flap,[37-39] its functional limitations[40] ultimately led surgeons to pursue alternative autologous methods. In 1982, Hartrampf and associates[41] introduced the pedicled TRAM flap[41] With its greater ability to achieve a natural-appearing, ptotic breast and secondary aesthetic improvements in the donor site,[4] this flap quickly supplanted the latissimus as the first choice for pedicled autologous breast reconstruction. Thirty years after its original description, this flap remains the most commonly used method of autologous breast reconstruction in the United States.[42]

A significant addition was made to the repertoire of available breast reconstruction techniques when Holmstrom[43] described the "free abdominoplasty flap" in 1979 and again in 1989, when Grotting and coworkers[14] introduced its routine use, citing a better skin island blood supply, easier flap inset, improved contour in the absence of a tunneled pedicle, and decreased abdominal donor-site morbidity. Despite a recent focus on free tissue transfer in the breast reconstruction literature and its now widespread availability, the pedicled TRAM and latissimus flaps remain highly relevant in community medical centers, where most

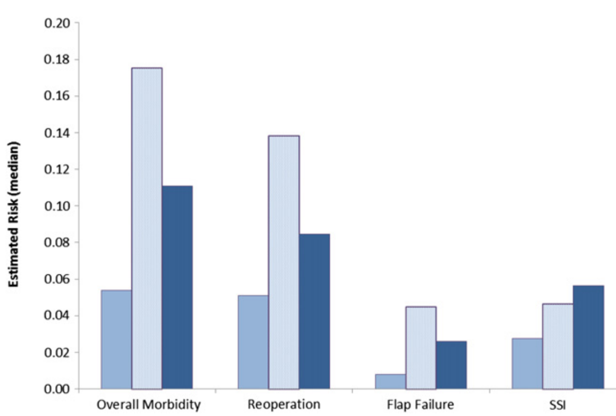

Figure 3. Expected outcomes by procedure type. Dark blue bars, TRAM flaps; striped bars, free; light blue bars, latissimus flaps. SSI, surgical site infection; TRAM, transverse rectus abdominis myocutaneous.

breast reconstruction is performed. In such centers, the intensive perioperative monitoring and highly specialized equipment needed for free tissue transfer is not routinely available.[42] In this large, unselected series, more than 81.5% of autologous reconstructions were pedicled TRAM (48.8%) or latissimus (32.7%) flaps; free flaps represented only 18.5% of reconstructions. This highlights the continued importance of pedicled flap breast reconstruction and the need for research comparing their outcomes to newer methods, particularly in light of an increasing national focus on medical economics.

Outcomes of autologous reconstruction

Currently available literature regarding optimal flap choice is not broadly generalizable, often reports conflicting results, and rarely compares more than 1 pedicled flap technique with free tissue transfer.[8,10,12-26] In this study, we directly compared pedicled TRAM flaps, latissimus flaps, and free tissue transfer to determine use and outcomes data in a widely representative female cohort. The NSQIP database is the largest multi-institutional database available with standardized data collection methods, minimizing selection bias in this study. These statistically powerful outcomes data can be used to guide future clinical decision-making and research efforts in the field of breast reconstruction.

Patients undergoing free tissue transfer were younger on average, and those undergoing abdominal-based flaps (including free flaps) had a higher mean BMI. Younger patients are more capable of tolerating the lengthy and complex procedure of free tissue transfer, and higher mean BMI likely reflects availability of abdominal tissue for autologous reconstruction.

Active smokers were significantly more likely to undergo latissimus-based reconstructions, and there was a trend toward active smokers being more likely to receive a pedicled TRAM flap than a free tissue transfer, although this failed to reach statistical significance. Interestingly, this contradicts a well-established body of literature that indicates free tissue transfer being better tolerated by such patients, particularly in the case of free vs pedicled TRAM flaps.[4,13,14,25,42,44-46]

The rates of overall complications, flap failure, reoperation, and blood transfusion were highest in the free tissue transfer group on univariate analysis; however, overall complications were found to be highest in the pedicled TRAM flap once the effect of flap type was controlled for in the multivariate analysis. Due to the inherent complexity of free flap procedures and their tenuous postoperative course, these results are in line with our expectations and clinical observations. It is likely that procedural complexity and resulting complications contributed to an unmasking effect in the multivariable analysis, which showed that pedicled TRAM flaps actually had the highest overall complication rates.

The incidence of DVT and PE were found to be highest in the pedicled TRAM group. Given that the patient undergoing an abdominal-based flap (free or pedicled) often has a much longer convalescence and latency to full ambulation than a latissimus dorsi flap patient, this is not unexpected. Moreover, reconstruction of the abdominal wall after removal of a TRAM flap raises intra-abdominal pressure, which may result in higher transmural pressure and venous pooling in the pelvic veins. This could potentially account for the higher observed rate. The significantly low number of DVT events in the free flap group ($n = 1$) is too small to draw statistical conclusions, and may be related to aggressive anticoagulation protocols aimed at preventing postoperative microvascular thrombosis.

The 30-day follow-up period in this study makes direct comparison of complications data to published series difficult; however, it is worth noting that although the observed complication rate of free tissue transfer (19.4%) is comparable to published rates of 23% to 30%,[25,26] the observed rate of latissimus flap complications (7.1%) is far lower than that in previous cohorts.[47-52] This must, however, be interpreted in context. As discussed below, the NSQIP database does not track seroma formation, the most common complication seen with latissimus flap breast reconstruction. Moreover, long-term complications associated with concomitant tissue expander use are not captured in this 30-day time frame. It should also be noted that certain high-volume microsurgical centers of excellence have been shown to have lower rates of overall complications with free tissue transfer. Our data are pooled from both community and university hospital systems.

Despite the limitations of the database, these findings are statistically significant, and support the argument of several previous publications[53-55] that the latissimus flap should not be relegated to a "second-line" choice. In light of the current findings, this thought process should be reconsidered. Besides being a local, robust flap with a known and reliable skin territory and fewer complications than all other autologous methods, this flap offers several additional advantages, including faster recovery times, high rates of patient satisfaction, and minimal donor site morbidity.[37-39] Sternberg and colleagues[53] argued that the latissimus flap, although often considered a second-line choice, is an excellent reconstructive option with predictable results that are easy to replicate. Our findings are in line with their conclusions, and question the designation of the latissimus flap as a secondary option.

Independent predictors of complications

Many of the independent predictors of complications identified in this study, including prolonged operative time, higher ASA classification, obesity, and previous surgery within 30 days, are not surprising. The factors have been associated with increased complications across multiple surgical disciplines, and logically extend to autologous breast reconstruction.[56-58] Increasing ASA classification and BMI are both indicators of worsening baseline health, and recent surgery may increase complications through various mechanisms related to a systemic, postsurgical inflammatory milieu.

In addition, delayed reconstruction independently predicted complications in all subgroups except for free tissue transfers. By definition, immediate reconstructions are combined with mastectomy, which prolongs total operative times compared with delayed reconstructions. Therefore, a factor besides length of operation must account for these observed differences. Because patients undergoing delayed reconstruction are more likely to have completed a course of radiation therapy, the increased complications rates observed may be independent of flap type, and may relate more to local, radiation-induced complications of the mastectomy skin flaps. However, delayed reconstruction was not an independent predictor of complications in the free flap cohort, which raises the question of whether or not free flaps perform better in the irradiated environment than pedicled flaps. Future studies will need to compare outcomes for various free and pedicled flaps in the postmastectomy radiated breast to answer this question.

Study limitations

The methodology of the NSQIP presents several limitations. Foremost, complications are tracked only for a 30-day postoperative period, which may not account for certain long-term flap and donor-site complications, such as fat necrosis and abdominal-wall hernia or bulge.

We found that active smokers were most likely to undergo pedicled latissimus flaps. Recent literature favors free flaps as the ideal autologous reconstruction in smokers—presumably secondary to enhanced blood flow to the tissues. We believe this predilection for latissimus flaps is likely a reflection of resource distribution in an unselected, nationwide series rather than disagreement with current practice recommendations. That is to say, patients seeking autologous reconstruction may not have ready access to microsurgery.

The brief follow-up may similarly skew the complication distribution toward free tissue transfer, as relatively more early complications, particularly flap related, occur in this group compared with the pedicled flap group.

Moreover, some highly relevant complications of breast reconstruction (hematoma, seroma, fat necrosis, and abdominal wall morbidity after TRAM flaps) are not specifically tracked by NSQIP. With latissimus flaps having published seroma rates of 20% to 79%,[37,47,49-51,53,59] absence of seroma reporting likely decreased the complications observed in this group. However, the significance of seroma as a major, potentially reoperative morbidity is low,[53,60] particularly in the 30-day postoperative period (30-day reoperation rate of 5.7% in this series). The NSQIP's 30-day follow-up period also fails to capture any associated expander to implant exchange procedures for the 28.7% of latissimus flaps with an ipsilateral tissue expander (data not shown), and their associated complications. In addition, NSQIP does not track radiation therapy occurring more than 90 days from the time of operation. Similarly, certain outcomes important to patients and reconstructive surgeons, including patient satisfaction, esthetic outcomes, and subsequent flap revisions, are not reported to NSQIP, and minor modifications in technique (ie, use of a bipedicled TRAM flap) cannot be tracked.

Last, despite the size of the cohort presented by NSQIP, the large number of participating institutions likely introduces a significant surgeon variability factor. Moreover, our baseline populations were not identical in terms of BMI distribution and smoking status; more smokers underwent latissimus dorsi flap breast reconstruction and patients undergoing abdominal-based flaps were more likely to undergo pedicled or free TRAM flaps. Therefore, both patient and surgeon variability cannot be overlooked in interpreting the results.

Despite its shortcomings, the NSQIP database does provide our specialty with a cohort of nearly 3,300 autologous breast reconstruction patients from more than 240 institutions across the country, and enables us to analyze more than 790,000 data points. Unlike many previously published series, these data are pooled from both community and university-based hospital systems, which makes the findings of this study more generalizable than many of the existing single-surgeon or single-center series available.

CONCLUSIONS

The 2006 to 2010 NSQIP database has allowed direct comparison of autologous methods of breast reconstruction in nearly 3,300 patients from more than 240 institutions across the United States. The nationwide use of pedicled flap autologous breast reconstruction remains high, at 81.5%. Our multivariate regression analysis showed that the 30-day complication outcomes of pedicled flaps, particularly the latissimus flap, are correspondingly lower than those for free flaps. Integrating this information into the patient-physician dialogue before breast reconstruction will help broaden patient education and guide informed decision-making.

Author Contributions

Study conception and design: Gart, Smetona, Kim
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