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Ipsilateral pedicle TRAM flaps for breast reconstruction: are they as safe as contralateral techniques?

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Summary *Introduction:* Many surgeons are using the ipsilateral rotation of the TRAM flap because of easier flap inseting and improved aesthetic outcomes; however studies evaluating these techniques are limited to case series without groups for comparison. Our purpose was to evaluate the safety of the ipsilateral technique through a retrospective cohort study.

Methods: We retrospectively evaluated consecutive contralateral and ipsilateral TRAM flaps for mastectomy breast reconstruction. The incidence of ischemia-related flap complications and the incidence of major and minor complications were compared between the two groups. Multiple logistic regression was used to assess the effect of rotation type on complication rates, while controlling for potential confounding variables.

Results: Comparing 58 ipsilateral to 32 contralateral pedicle TRAM patients, the rate of a major complication was 20.7% and 28.1%, respectively, $p = 0.425$; a minor complication was 50.0% vs. 34.4%, respectively, $p = 0.153$; and total ischemic-related flap complications were 22.4% and 25.0% respectively, $p = 0.781$. When controlling for potential confounders, the type of pedicle TRAM flap did not have a significant effect on the above complications. Advanced patient age was significantly correlated with an increased incidence of major complications ($OR = 1.09$, $p = 0.031$) and ischemic flap complications ($OR = 1.11$, $p = 0.016$).

Conclusion: The ipsilateral pedicle TRAM flap appears as safe as the contralateral technique for breast reconstruction. Given the increased pedicle length and preservation of both the

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medial inframammary fold and xiphoid subunit, we believe that the ipsilateral technique is preferred over the contralateral rotation.

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Despite the popularity of perforator flaps for breast reconstruction, many surgeons in academic and community settings still perform pedicle TRAM procedures. Although pedicle TRAM reconstruction is a well-established procedure, several technical variations exist. The outcomes associated with these technical variations, namely the ipsilateral vs. contralateral rotation of the pedicle TRAM flap, are not well established. The ipsilateral rotation is the original technique described for the pedicle TRAM.¹ However, many surgeons were concerned that the ipsilateral rotation added tension on the pedicle, potentially leading to vascular compromise of the flap. Surgeons turned to the contralateral rotation of the pedicle TRAM flap in an effort to decrease the tension on the vascular pedicle. However, the contralateral flap was found to have aesthetic limitations from disruption of the xiphoid subunits and the medial inframammary fold along with inset restrictions from the shorter pedicle length.²⁻⁵

With the variety of breast reconstruction techniques available, choosing the 'right' operation often proves to be daunting for both physicians and consumers. Outcomes research can provide physicians and patients with objective, reliable information to assist in reconstructive decision-making. Many surgeons are now using the ipsilateral technique because of easier flap inset and improved aesthetic outcomes, but studies evaluating the outcomes of these two techniques are limited to non-controlled case series without groups for comparison. The purpose of this study was to compare the outcomes associated with ipsilateral and contralateral pedicle TRAM reconstruction as a retrospective cohort study. We hypothesized that patients with ipsilateral pedicle TRAM flaps would have a higher incidence of partial flap loss and fat necrosis compared to those with contralateral pedicle TRAM procedures.

Methods

Study population

The study included consecutive patients receiving pedicle TRAM flap breast reconstruction by the senior author between 1996 and 2006. Specifically, women undergoing first-time immediate or delayed unilateral pedicle TRAM flaps were included. Women had either ipsilateral or contralateral muscle-sparing pedicle TRAM reconstructions. We excluded patients with microvascular super-charging of the flap and those receiving a bipedicle TRAM flap.

Data collection

Retrospective chart review data was performed to obtain clinical and demographic information such as: height, weight, body-mass index (BMI), age, comorbidities and type of cancer. We also obtained data on previous abdominal surgery, recent tobacco usage, and receipt of preoperative

and postoperative chemotherapy and radiation therapy. Procedural information included type of pedicle TRAM (ipsilateral vs. contralateral), timing of the procedure (immediate vs. delayed), use of a surgical delay of the flap and use of mesh for the abdominal wall closure.

The primary dependent variable of interest was complications which occurred within the six-month postoperative period. Complications were evaluated in two ways. First, we assessed the incidence of ischemia-related complications of the flap. This was defined as having at least one of the following flap complications: total flap loss (100% flap loss), partial flap loss (< 100% flap loss) requiring operative intervention or salvage procedure, partial flap loss (< 100% flap loss) treated non-operatively, and palpable fat necrosis removed at the time of a different procedure (such as during nipple reconstruction). Complications were then categorized in either major or minor groups. Major complications included those which required readmission to the hospital or operative intervention, such as; cellulitis requiring IV antibiotics, pulmonary embolism, sepsis, infected abdominal wall mesh requiring surgical removal, hematoma or seroma requiring surgical drainage, hernia requiring operative repair, ileus, acute renal failure, and total or partial flap loss requiring surgical revision or salvage procedure. Minor complications included those complications which did not require hospital admission or operative intervention, such as; cellulitis treated with oral antibiotics, seroma or hematoma not requiring operative drainage, abdominal wall laxity not requiring operative correction, palpable fat necrosis, and partial flap loss treated conservatively with topical solutions and dressing changes.

Analysis

Chi-square or Fischer exact tests were used for the bivariate comparisons of complications by procedure type (ipsilateral vs. contralateral). Logistic regression was used to evaluate the correlation between procedure type and surgical complications while controlling for demographic and clinical variables. Procedure type, radiation therapy, the presence of a comorbidity, and surgical TRAM delay were all two-level categorical variables. Age and BMI were analyzed as continuous variables. The Wald test and the likelihood ratio test were used to test the significance of individual predictive variables, and the model χ^2 statistic was applied to test the overall significance of the models. All analyses were performed with SAS Version 9.1 (SAS Institute Inc., Cary, NC) statistical software package, and statistical significance was set at $p \leq 0.05$.

Results

Table 1 summarizes the study population by procedure type. The study population included 90 patients, 58 with

Table 1 Study population by type of pedicle TRAM flap for breast reconstruction

	Ipsilateral Pedicle TRAM (N = 58) N (%)	Contralateral Pedicle TRAM (N = 32) N (%)	P value
Patient age, Mean	45.6	50.6	0.002 ^a
BMI, Mean	25.0	25.4	0.622 ^a
Immediate reconstruction	34 (58.6)	23 (71.9)	0.212 ^b
Surgical delay of flap	6 (10.3)	1 (0.3)	0.221 ^b
Tobacco use within last 6 months	2 (0.3)	1 (0.3)	0.537 ^c
Presence of at least 1 Co-morbidity	5 (8.6)	7 (21.9)	0.077 ^b
Pre or Post-operative radiation	26 (44.8)	12 (37.5)	0.500 ^b
Pre or Post-operative chemotherapy	7 (60.3)	15 (50.0)	0.353 ^b

^a One Way Anova.

^b Pearson's Chi-Square.

^c Fischer's Exact.

ipsilateral and 32 with contralateral pedicle TRAM flaps. Co-morbidities included hypertension, diabetes mellitus, asthma, Graves disease, hyperlipidemia, and hypothyroidism. The two procedure cohorts had similar clinical and demographic characteristics except that patients with ipsilateral pedicle TRAM flaps were significantly younger than those with contralateral pedicle TRAM flaps (45.6 vs. 50.6, respectively, $p = 0.002$).

Table 2 describes the categories of complications during the six-month follow-up in the study population. Comparing the ipsilateral with the contralateral TRAM group, the incidence of partial flap loss that did not require surgical intervention was 3.5% and 0%, respectively ($p = 0.537$); the incidence of partial flap loss requiring surgical excision or revision was 5.2% and 9.4%, respectively ($p = 0.662$), and the incidence of palpable flap fat necrosis that was removed in conjunction with another surgical procedure was 13.8% and 15.6%, respectively ($p = 0.813$). Total flap loss did not occur in either surgical group. The incidence of having at least one of the ischemic-related complication of the flap was 22.4% in the ipsilateral group and 25.0% in the contralateral group ($p = 0.78$). Major complications were noted in 20.7% of the ipsilateral TRAM patients and 28.1% of the contralateral group, respectively ($p = 0.425$). Minor complications were noted in 50.0% of the ipsilateral TRAM

patients and in 34.4% of the contralateral group, respectively ($p = 0.153$). When individual complications were compared by procedure group, wound infections requiring IV antibiotics was the only complication that was significantly different between the two groups, which occurred in 13.8% of patients with an ipsilateral TRAM and 0% of patients with a contralateral TRAM ($p = 0.047$).

Logistic regression was used to assess the effect of procedure technique (ipsilateral versus contralateral) on major, minor and ischemic flap complications while controlling for patient age, BMI, preoperative and post-operative radiation, procedure timing, surgical delay of the flap and comorbidities (Tables 3–5). When controlling for these independent variables, the type of pedicle TRAM flap (ipsilateral vs. contralateral), had no significant effect on major complications, minor complications or the incidence of ischemic-related complications of the flap. However, there was a trend towards lower rates of minor complications in patients with contralateral procedures ($OR = 0.39$, $p = 0.066$). In addition, advanced patient age was significantly correlated with an increased incidence of major complications ($OR = 1.09$, $p = 0.031$) and ischemic flap complications ($OR = 1.11$, $p = 0.016$). The relationship between patient age and ischemic flap complications is displayed in Figure 1.

Table 2 Ipsilateral and contralateral pedicle TRAM Flap six month postoperative complications

	Ipsilateral pedicle TRAM (N = 58) N (%)	Contralateral pedicle (N = 32) TRAM N (%)	P -value
Complete flap loss	0	0	1.00
Partial flap loss (<100% flap) not requiring surgery	2(3.5)	0 (0)	0.537
Partial flap loss (<100% flap) requiring excision or salvage procedure	3(5.2)	3(9.4)	0.662
Palpable fat necrosis	8 (13.8)	5(15.6)	0.813
Ischemic-related flap complications ^a	13 (22.4)	8 (25)	0.781
Major complication ^b	12 (20.7)	9 (28.1)	0.425
Minor complication ^c	29 (50.0)	11 (34.4)	0.153

^a Defined as having at least one of the following flap complications: Complete flap loss, partial flap loss treated operatively, partial flap loss treated non-operatively, and palpable fat necrosis.

^b Any complication that required hospital admission or operative procedure.

^c Any complication that did not require hospital admission or operative procedure.

Table 3 Multivariate analysis of correlates of a major complication with pedicle TRAM breast reconstruction

Independent variable	Adjusted odds ratio (95% confidence interval)	P -value
Ipsilateral ^a vs. contralateral	1.05 (0.34, 3.18)	0.937
Surgical delay of flap	0.83 (0.12, 5.99)	0.855
Age	1.09 (1.0, 1.18)	0.031
BMI	1.05 (0.89, 1.23)	0.575
Timing (immediate ^a vs. delayed)	0.78 (0.24, 2.55)	0.682
History of pre or postoperative radiation	0.68 (0.21, 2.22)	0.520
Presence of at least one comorbidity	1.13 (0.27, 4.84)	0.865

^a Reference group.

Discussion

The original description of the TRAM flap for breast reconstruction by Hartrampf¹ was an ipsilateral rotation of the flap. However, many surgeons have modified the technique by raising a contralateral flap because of concerns of folding of the pedicle and compromising the vascular supply⁶⁻⁸. Surgeons were also concerned that the vascular supply to the ipsilateral flap could be compromised by radiation and/or lymph node dissection of the internal mammary chain. Unfortunately, the contralateral rotation of the TRAM flap has aesthetic disadvantages. Flap inseting is limited due to a longer distance to the mastectomy defect, which can lead to shelving of the upper pole and poor breast mound projection. The medial breast subunits, such as the xiphoid and medial inframmary fold, are also disrupted with the contralateral rotation.²⁻⁵ For these reasons, it is not uncommon for surgeons to return to the original ipsilateral description of this flap,^{2,4,8-10} the safety of which is supported by our data.

In this retrospective cohort study, we found that major and minor complication rates and the incidence of

Table 4 Multivariate analysis of correlates of a minor complication with pedicle TRAM breast reconstruction

Independent variable	Adjusted odds ratio (95% confidence interval)	P -value
Ipsilateral ^a vs. contralateral	0.39 (0.14, 1.06)	0.066
Surgical delay of flap	5.16 (0.51, 51.87)	0.164
Age	1.03 (0.97, 1.09)	0.411
BMI	0.97 (0.85, 1.10)	0.604
Timing (immediate ^a vs. delayed)	0.70 (0.25, 1.97)	0.502
History of pre or postoperative radiation	0.47 (0.17, 1.29)	0.144
Presence of at least one comorbidity	0.66 (0.19, 2.30)	0.516

^a Reference group.

Table 5 Multivariate analysis of correlates of an ischemia-related flap complication in pedicle tram breast reconstruction

Independent variable	Adjusted odds ratio (95% confidence interval)	P value
Ipsilateral ^a vs. contralateral	0.52 (0.15, 1.75)	0.290
Surgical delay of flap	2.53 (0.22, 28.63)	0.453
Age	1.11 (1.02, 1.20)	0.016
BMI	1.06 (0.90, 1.24)	0.483
Timing (immediate ^a vs. delayed)	0.63 (0.18, 2.17)	0.465
History of pre or postoperative radiation	0.56 (0.17, 1.92)	0.357
Presence of at least one comorbidity	0.27 (0.07, 1.06)	0.060

^a Reference group.

ischemic-related flap complications were not significantly different between ipsilateral or contralateral pedicle TRAM procedures. However, after accounting for patient and procedure factors, our cohort study did find that the incidence of minor complications trended towards higher rates in patients with ipsilateral TRAM procedures ($p = 0.066$). This is similar to Clugston et al's study of ipsilateral TRAMs in which the authors reported a moderately high minor complication rate but a relatively low major complication rate.⁴ The rate of minor complications in our ipsilateral group was high at 50%. Minor complications included wound infection treated with oral antibiotics, seroma or hematoma not requiring operative drainage, abdominal wall laxity not requiring operative correction, fat necrosis removed at the time of a different procedure (such as at the time of nipple areolar reconstruction), and minor partial flap loss treated conservatively with topical solutions and dressing changes. Major complications and complications suggestive of vascular insufficiency were comparable to that of the contralateral TRAM group.

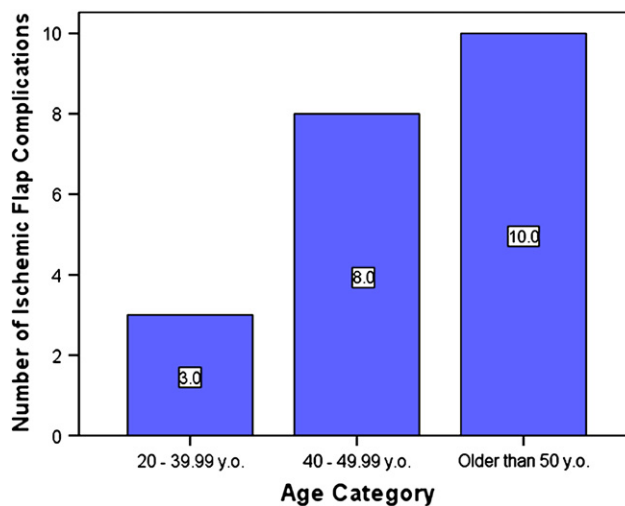


Figure 1 Relationship between patient age and the incidence of Ischemic flap complications.

In addition, although the use of the ipsilateral TRAM in a previously irradiated breast is concerning because of possibility of damage to the internal mammary vessels,^{11,12} our findings suggest that pre or postoperative radiation is not significantly correlated with flap ischemia or with major or minor complications. A recent study of radiated and non-radiated ipsilateral TRAM flaps by Bristol et al. revealed no difference in partial and complete flap loss, mastectomy flap loss, infection, and revision rates between the two treatment groups.¹³ Furthermore, radiologic studies performed by Marin-Gutzke et al. confirmed the communications between the costomarginal artery and the deep epigastric system which can be considered as an alternative or adjuvant vascular pedicle of the deep superior epigastric artery in cases of potential lesion of the ipsilateral internal mammary vessel.⁹

An interesting finding in this study was the association between advanced patient age and the increased incidence of major complications and ischemic flap complications, even after controlling for the presence of comorbidities. In particular, 30.3% of patients aged 50 years or greater had an ischemic-related flap complication compared to only 19.3% of those under 50 years of age. After controlling for patient age, BMI, preoperative and postoperative radiation, procedure timing, surgical flap delay and patient comorbidities, the results of our regression analysis suggest that for every year increase in age, there was an 11% increase in the odds of ischemic flap complications and a 9% increase in the odds of major complications. Previous research assessing the impact of age on complications with breast reconstruction has been limited. However, age is considered by some to be an independent risk factor for suboptimal surgical results. Although there are no clear lines separating youth from middle age or old age, there are documented changes in wound healing,¹⁴ infection rates,¹⁵ gastrointestinal anastomotic leak, cardiac index, and renal function related directly to patient age.¹⁶ Our previous research with the Michigan Breast Reconstruction Outcomes Study- a multi-surgeon, multi-center prospective cohort study-did not support an association between patient age and post-mastectomy complications for patients undergoing either pedicle or free TRAM flaps for breast reconstruction.¹⁷ However, regressions for ischemia related flap complications were not performed in that study. It is possible that the reliability of the vascular pedicle for the TRAM flap decreases with age. This concept warrants further investigation.

Our findings should be interpreted in the context of some limitations. This was a retrospective design and, as such, unaccounted for factors may affect our outcomes. However, by using a single surgeon, case series that includes a control group, we could directly compare the outcomes of these two commonly performed procedures, which has previously not been reported. And, by using statistical regression models, we could control for important clinical factors that may affect complications, such as BMI and age.

Implications

Ipsilateral and contralateral pedicle TRAM flaps appear to be equally safe techniques for for post-mastectomy breast

reconstruction. Surgeons should choose their technique based on their best aesthetic results with flap rotation and inseting. We believe that the ipsilateral compared to the contralateral pedicle TRAM flap offers considerable benefits such as inseting versatility and preservation of the inframammary fold and the xiphoid subunit.

Statement of financial interest

Janiga, Atisha, Lytle, Wilkins, and Alderman have no financial or commercial interests related to this research.

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