

Pedicle Transverse Rectus Abdominis Muscle Flap Breast Reconstruction: A Comparative Study

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Abstract

Aim: To address concerns regarding the pedicle TRAM flap by providing a detailed and up-to-date analysis of the morbidity associated with the procedure when polypropylene mesh is used to reinforce the abdominal wall repair.

Material & Methods: 100 patients underwent breast reconstruction with pedicle TRAM flaps at Department of Surgery, JLNMC, Bhagalpur, Bihar, India. All patients played an active role in the decision-making process and were provided the option of pedicle flaps, free flaps, or implant-based reconstruction.

Results: During the study period, 100 patients underwent pedicle TRAM flap breast reconstruction by the senior author (J.A.A.). Unilateral pedicle TRAM flaps were performed in 55 patients and bilateral procedures were performed on 45 patients. All of these flap complications occurred in unilateral TRAM flap patients, with a rate of 20.1% in the unilateral group vs. 0% in the bilateral group ($P = 0.005$). Obesity was significantly associated with donor site complications independent of other risk factor contributions (OR, 6.12; $P = 0.001$).

Conclusions: The pedicle TRAM flap continues to be an excellent option for breast reconstruction. Complication rates for both unilateral and bilateral TRAM flaps were low in this series, with no complete flap losses and just 4.3% of patients requiring a return to the operating room secondary to morbidity.

Keywords: Breast reconstruction, breast cancer, surgical flaps

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Introduction

Transplantation of a transverse rectus abdominis myocutaneous (TRAM) flap is a commonly used surgical procedure for breast reconstruction following mastectomy. In this procedure, an autologous myocutaneous flap consisting of abdominal skin, subcutaneous fat, the

rectus abdominis muscle, and adjoining vasculature is used for reconstruction of the breast following mastectomy. Since the description of this procedure by Hartrampf et al [1] in 1982, numerous refinements of the basic technique have been developed, which include the pedicle, free, and

delayed flap reconstruction [2]. The mammographic and computed tomographic (CT) characteristics of normal and abnormal TRAM flap reconstructions have been previously reported in the literature [3, 4].

Breast reconstruction methods are varied but can be grouped into either autologous flaps or implant based techniques. Implant based breast reconstruction has been available since 1960 and was further refined in 1980 as a 2 staged procedure in conjunction with tissue expansion. Initially described by Dr. Hartrampf in 1982, the TRAM flap uses the excess skin and subcutaneous fat that is routinely discarded in a cosmetic abdominoplasty (i.e., “tummy tuck”) for breast reconstruction. In fact, the possibility of using the lower abdomen as a donor site for breast reconstruction was discovered during abdominoplasty procedures. Hartrampf observed that the lower abdomen could survive as an island of tissue as long as the attachments to the rectus sheath and underlying rectus muscle were kept intact. Because of the dual blood supply of the rectus abdominus muscle, the TRAM flap can be raised either as a pedicled flap based on the superior epigastric vessels or as a free flap based on the deep inferior epigastric vessels. Because of its versatility, the TRAM flap is the most common form of autologous breast reconstruction performed today. [5]

The purpose of this study is to address concerns regarding the pedicled TRAM flap by providing a detailed and up-to-date analysis of the morbidity associated with the procedure when polypropylene mesh is used to reinforce the abdominal wall repair.

Material & Methods:

100 patients underwent breast reconstruction with pedicled TRAM flaps at Department of Surgery, JLNMC, Bhagalpur, Bihar, India. All patients played an active role in the decision-

making process and were provided the option of pedicled flaps, free flaps, or implant-based reconstruction.

The pedicled TRAM flap procedure was performed as described previously, employing an onlay polypropylene mesh to reinforce the abdominal wall closure. Reconstructions used the full width and a variable length of the rectus abdominis muscle. Patient charts were reviewed retrospectively for complications, including complete and partial flap loss, fat necrosis, infection, seroma, hematoma, abdominal hernia or bulge, skin loss, mesh removal, umbilical ischemia or stenosis, revision of the abdominal closure, and persistent abdominal wall discomfort requiring physical therapy referral.

Complete flap loss was defined as necrosis of 50% or more of the TRAM flap, whereas partial flap loss was defined as necrosis of less than 50% of the flap. Infection was defined as any signs of infection of the breast or abdomen requiring antibiotics or an incision and drainage procedure. Hernia was defined as any postoperative abdominal wall fascial defect. Abdominal bulge was defined as protrusion of the abdominal wall apparent on clinical examination but without an obvious fascial defect. Skin loss was defined as any full thickness skin necrosis. Fat necrosis was defined as any subcutaneous tissue firmness persisting for at least 5 months following surgery that was treated with resection, either in the office or in the operating room, and was pathologically confirmed as fat necrosis. Seroma was any detectable collection of serous fluid.

Data regarding patient demographics and possible risk factors were analyzed and included age, body mass index (BMI), diabetes, smoking history, previous abdominal surgery, radiation history, and chemotherapy history (Table 1). Patients were divided into age <60 or ≥60. BMI was categorized into normal (<25.0), overweight (≥25 and <30), or obese (≥30).

Smoking history was subdivided into nonsmokers, former smokers (quit at least 4 weeks before surgery), or active smokers. Radiation history was divided into preoperative and postoperative radiation. Chemotherapy history was divided into neoadjuvant only, postoperative, and combined neoadjuvant and postoperative chemotherapy.

All statistical analyses were performed using the MedCalc statistics software (MedCalc Inc., Belgium), and statistical significance was defined as $P < 0.05$. In Tables 2 and 3, the 2-tailed Fisher's exact test was used to compare bilateral and unilateral complication rates. The χ^2 test was then used to determine independence of risk factors before regression analysis. Logistic regression analysis was performed to identify associations between potential risk factors and complications and is represented in Tables 4 and 5. Categories with a sample size greater than 10 were included in the regression models. Categorical variables were represented with dummy variables. Stepwise regression was performed in Table 5 with exclusion of risk factors resulting in $P > 0.1$ to strengthen the reproducibility of the regression model in identifying risk factor associations.

Results:

During the study period, 100 patients underwent pedicled TRAM flap breast reconstruction by the senior author (J.A.A.). Unilateral pedicled TRAM flaps were performed in 55 patients and bilateral procedures were performed on 45 patients.

The mean follow-up period was 34 months, with a range of 3 months to 12 years, and the average length of hospital stay was 4 days. Patient demographics are summarized in Table 1.

The mean patient age was 46.22 years, with a range of 29–72. Average BMI was

25.5, with 55% of patients classified as normal weight, 38% overweight, and 13% obese. Active smoker's comprised 2%, and 17% of patients were former smokers. One patient had a history of diabetes.

Flap site complications occurred in 17 patients (Table 2); however, the majority of these were treated in the office, and only 7 patients required a return to the operating room for a flap site-related complication. Furthermore, all of these flap complications occurred in unilateral TRAM flap patients, with a rate of 20.1% in the unilateral group vs. 0% in the bilateral group ($P = 0.005$).

Donor site morbidity occurred in 23.6% of unilateral and 35.5% of bilateral patients ($P = 0.122$) (Table 3). As with flap site-related complications, the majority of these donor site complications were relatively minor and were treated in the office. Only 1 bilateral patient (4.2%) and 2 unilateral patients (1.2%) required a return to the operating room for donor site morbidity.

Obesity was significantly associated with donor site complications independent of other risk factor contributions (OR, 6.12; $P = 0.001$) (Table 4). A history of former or active smoking ($P = 0.1279$), 2 or more adjuvant therapies (0.1777), age over 60 ($P = 0.5281$), and prior abdominal surgery ($P = 0.1000$) were not associated with a higher rate of donor site complications.

Of the specific flap site complications, partial flap loss was strongly associated with a history of 2 or more adjuvant therapies (OR, 6.72; $P < 0.005$) and obesity (OR, 4.17; $P = 0.02$) (Table 5). The odds of fat necrosis were greater in patients who were current or former smokers (OR, 4.52; $P = 0.02$). Age over 60 and prior abdominal procedures were not associated with a higher rate of flap site complications.

Table 1: Patient Demographics and History

| | Value No. (%) |
|-----------------------------------------------------|---------------|
| No. of patients | 100 |
| Average Age (In years) | 46.22 |
| Range | 29 – 72 |
| Age \geq 60 | 9 |
| Mean BMI, kg/m ² BMI Profile | 25.5 |
| <25 kg/m ² (normal weight) | 55 |
| \geq 25–29.9 kg/m ² (overweight) | 38 |
| \geq 30 kg/m ² (obese) Smoking history | 13 |
| No smoking history | 78 |
| Former smokers | 17 |
| Active smokers | 2 |
| Diabetes | 1 |
| Chemotherapy history | 40 |
| Neoadjuvant chemotherapy | 2 |
| Postoperative chemotherapy | 38 |
| Both neoadjuvant and postoperative chemotherapy | 2 |
| Radiation history | 29* |
| Preoperative radiation | 10 |
| Postoperative radiation | 15 |
| Prior abdominal surgery | 41 |
| Delayed | 5 |

Table 2: Flap Site Complications in Unilateral vs. Bilateral TRAM Flap Patients

| Flap Site Complications | Unilateral TRAM Flap Patients (n = 55) | Bilateral TRAM Flap Patients (n = 45) | Unilateral and Bilateral TRAM Flap Patients (n = 100) | P* |
|--------------------------|----------------------------------------|---------------------------------------|-------------------------------------------------------|-------|
| Complete flap loss | 0 | 0 | 0 | — |
| Partial flap loss | 7 | 0 | 7 | 0.482 |
| Fat necrosis | 5 | 0 | 5 | 0.201 |
| Infection | 2 | 0 | 2 | 0.391 |
| Seroma | 2 | 0 | 2 | 1.381 |
| Hematoma | 1 | 0 | 1 | 1.629 |
| Total flap complications | 17 | 0 | 17 | 0.005 |

Table 3: Donor Site Complications in Unilateral vs. Bilateral TRAM Flap Patients

| Donor Site Complications | Unilateral TRAM Flap Patients (n = 55) | Bilateral TRAM Flap Patients (n = 45) | Unilateral and Bilateral TRAM Flap Patients (n = 100) | P* |
|--------------------------|----------------------------------------|---------------------------------------|-------------------------------------------------------|-------|
| Abdominal hernia | 1 | 2 | 3 (1.6) | 0.022 |

| | | | | |
|---------------------------------------------------------|----|---|---------|-------|
| Abdominal bulge | 1 | 0 | 1 (0.5) | 1.312 |
| Skin loss | 1 | 1 | 1 (1.6) | 0.090 |
| Abdominal infection | 3 | 0 | 1 (1.6) | 1.427 |
| Abdominal seroma | 0 | 0 | 0 (0) | 1.820 |
| Abdominal hematoma | 1 | 0 | 1 (0.5) | 1.217 |
| Removal of palpable mesh edge | 1 | 1 | 2 (1.1) | 0.428 |
| Umbilical ischemia | 3 | 1 | 4 | 0.517 |
| Umbilical cyst | 1 | 0 | 1 | 1.523 |
| Umbilical stenosis | 1 | 0 | 1 | 1.771 |
| Revision of abdominal closure | 0 | 0 | 0 | — |
| Persistent abdominal discomfort—referred for therapy | 2 | 1 | 2 | 0.201 |
| Total number of patients with a donor site complication | 13 | 4 | 17 | 0.122 |

Table 4: Multivariate Analysis of Independent Risk Factors for the Development of Flap Site, Donor Site, and Overall Complications after Pedicled TRAM Flap

| | No. Patients with Complication/No. Patients | % of Patients in Group with Complication | Odds Ratio | <i>P</i> |
|----------------------------------------------------|---------------------------------------------|------------------------------------------|------------|----------|
| Flap site* | | | | |
| Former or active smoking | 8/21 | 38.0 | 1.5281 | 0.1722 |
| Obesity | 2/11 | 18.1 | 2.1102 | 0.1628 |
| Age over 60 | 4/12 | 33.3 | 1.7192 | 0.8152 |
| Prior abdominal surgery | 9/62 | 14.5 | 0.7192 | 0.6293 |
| Two or more adjuvant therapies Donor site | 7/27 | 25.9 | 3.6280 | 0.0021 |
| Former or active smoking | 7/20 | 35 | 1.2931 | 0.6281 |
| Obesity | 9/15 | 60 | 6.7201 | 0.0011 |
| Age over 60 | 1/11 | 9.0 | 0.4472 | 0.6828 |
| Prior abdominal surgery | 5/61 | 8.1 | 0.2910 | 0.1729 |
| Two or more adjuvant therapies Total complications | 1/20 | 5 | 0.2810 | 0.1777 |
| Former or active smoking | 6/18 | 33.3 | 1.4391 | 0.1279 |
| Obesity | 4/17 | 23.5 | 4.5272 | 0.0020 |
| Age over 60 | 2/14 | 14.2 | 0.5528 | 0.5281 |
| Prior abdominal surgery | 7/12 | 58.3 | 0.7720 | 0.1000 |
| Two or more adjuvant therapies | 8/15 | 53.3 | 2.4111 | 0.0528 |

Table 5: Multivariate Analysis of Selected Individual Complications by Significant Risk Factors

| Individual Complication | Odds Ratio | <i>P</i> |
|-------------------------|------------|----------|
| Partial flap loss* | | |

| | | |
|-------------------------------------------------|--------|--------|
| Obesity | 4.1724 | 0.0281 |
| Two or more adjuvant therapies Fat necrosis† | 6.7290 | 0.0005 |
| Former or active smoking | 4.5281 | 0.0218 |

Discussion:

The overall incidence of fat necrosis in our series was 32%, a rate higher than the 14.2% in a large series reported by Kim *et al.* [6]. This difference might be because we kept zones 1–3 of the TRAM flap in most patients, whereas in the study of Eun Key Kim *et al.*, only zones 1 and 3, which had better blood supply, were used for reconstruction.

The decision to undergo breast reconstruction is increasingly popular and has been shown to provide substantial psychological benefit. [7] Reconstruction options run the entire gamut, from alloplastic implants to autologous flaps in the various forms, be it donor site-differentiated, free or pedicled. Although autologous microvascular reconstruction with the DIEP flap is currently recognized as one of the best choices for breast reconstruction, [8] the conventional pedicled TRAM flap remains an extremely popular option in our institution because of its reliable vascularity, lower risk of total flap loss, relative ease of dissection and short operative time. However, full-width muscle harvest results in a number of donor-site concerns, particularly if a wide amount of overlying muscle fascia is concomitantly harvested. Full muscle harvest could result in abdominal wall weakness and a large fascia defect could predispose to abdominal bulges, [9] leading to a prolonged time to ambulation and rehabilitation, chronic lower back pain and core muscle instability.

In order to address these concerns, MS free flaps, such as the free MS-TRAM flap and the DIEP flap, have been performed, aiming for minimal disruption of the donor muscle, thereby preserving functionality and reducing morbidity. However, these techniques require technically demanding

microsurgical intramuscular dissection of the perforating vessels and also greatly increase operating time. Other concerns include the inconsistency in perforator size, quantity, and location, requiring more experience, specialized equipment and skill to perform such flap procedures safely and quickly. Total flap loss rates (0%–5% in DIEP flaps) [10-11] are also higher than the conventional pedicled TRAM flap (0%–3%). [12-13]

Our overall donor site complication rate was 11.2%, which compares favorably to previously reported donor site complication rates after free flap reconstruction. [14] Rates of hernia and abdominal bulge development after pedicled TRAM flaps have varied in the literature, with reported hernia rates ranging from 0% to 16% and abdominal bulge rates from 3.6% to 82%. [15-16] our rates of abdominal hernia (1.6%) and bulge (0.5%) formation compare favorably with those reported after pedicled TRAM flap and free flap reconstruction. [17-18] Two patients experiencing a hernia in our series of 100 patients underwent successful hernia repair and have had no secondary abdominal wall complications. We attribute these low rates to the use of an onlay polypropylene mesh to reinforce abdominal repairs. As no patient required mesh removal for infection, we believe that the use of mesh is well worth the small additional operating room time required to place it in all patients. [19]

Conclusion:

The pedicled TRAM flap continues to be an excellent option for breast reconstruction. Complication rates for both unilateral and bilateral TRAM flaps were low in this series, with no complete flap losses and just 4.3% of patients requiring a

return to the operating room secondary to morbidity.

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