Surgical Outcomes of VRAM versus Thigh Flaps for Immediate Reconstruction of Pelvic and Perineal Cancer Resection Defects

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Background: Reconstruction following abdominoperineal resection or pelvic exenteration is commonly performed with regional flaps from the thigh or abdomen. This study compared the surgical outcomes and complications in cancer patients who underwent immediate reconstruction of these defects with vertical rectus abdominis myocutaneous (VRAM) versus thigh flaps.
Methods: One hundred thirty-three patients who underwent abdominoperineal resection or pelvic exenteration for cancer resection and immediate VRAM ($n = 114$) or thigh flap ($n = 19$) reconstruction of the perineal/pelvic defect were studied. Patient, tumor, and treatment characteristics; surgical outcomes; and postoperative donor- and recipient-site complications were compared between the two groups. Multivariate logistic regression analysis was used to identify predictive/protective factors for complications.
Results: The thigh flap group had a significantly greater incidence of major complications (42 percent versus 15 percent) than the VRAM flap group. They also had significantly higher rates of donor-site cellulitis (26 percent versus 6 percent) and recipient-site complications, including cellulitis (21 percent versus 4 percent), pelvic abscess (32 percent versus 6 percent), and major wound dehiscence (21 percent versus 5 percent). Abdominal wall complications were not increased in the VRAM group despite flap harvest from the abdominal wall. Obesity was an independent predictor of any donor-site complication (odds ratio, 3.3) and previous abdominal surgery was a predictor of any complication (odds ratio, 3.6), any recipient-site complication (odds ratio, 3.5), and any major complication (odds ratio, 3.6).
Conclusion: Immediate VRAM flaps result in fewer major complications than thigh flaps without increased early abdominal wall morbidity when used to repair abdominoperineal resection and pelvic exenteration defects. (*Plast. Reconstr. Surg.* 123: 175, 2009.)

Treating primary and recurrent anorectal and other pelvic malignancies often requires extensive resection, such as pelvic exenteration or abdominoperineal resection, and chemotherapy and radiotherapy. Immediate flap reconstruction for the large pelvic/perineal defects created by resection has been shown to result in fewer wound complications than primary closure methods.[1–7] Flaps reduce complications by obliterating pelvic dead space; recruiting healthy, well-vascularized tissue into the region, which has commonly been irradiated and contaminated; and interposing a flap skin between irradiated perineal wound edges.[1,3–11] Two of the most commonly used groups of flaps for the repair of abdominoperineal resection and pelvic exenteration defects are pedicled thigh flaps[2,8,10,11] and pedicled rectus abdominis flaps,[1,3,4,6,12–14] particularly inferiorly based vertical rectus abdominis myocutaneous (VRAM) flaps.

There is some debate in the literature as to whether thigh or rectus abdominis flaps are better for immediate repair of pelvic/perineal defects.[3,4]

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Some authors propose that the thinner thigh flaps are better for contouring the perineum and creating a neovagina in women; thigh flaps also provide adequate bulk for filling pelvic dead space and have acceptable rates of perineal wound complications.[2,8,10,11] In addition, thigh flaps are thought to have lower rates of ventral hernia, seroma, and skin or fascial dehiscence than rectus abdominis flaps. Other surgeons believe that VRAM flaps are preferable because they have a more reliable skin paddle and provide more bulk to obliterate dead space.[3,5,6,8,12] VRAM flaps also have excellent viability because of their robust and consistent vascularity, preclude creation of an additional donor-site wound location, and have a long arc of rotation to reach distal defects.

To our knowledge, no study has directly compared the outcomes of thigh and VRAM flaps for immediate reconstruction of abdominoperineal resection and pelvic exenteration defects. Knowledge of the likely outcomes and complications of these two flap procedures would help surgeons choose the optimal flap for each patient and improve patient counseling. The goal of our study was to compare the surgical outcomes and complications of immediate VRAM and thigh flap reconstructions for abdominoperineal resection and pelvic exenteration defects in cancer patients. We hypothesized that pedicled VRAM flaps would result in better surgical outcomes and fewer major complications than pedicled thigh flaps but have greater abdominal wall morbidity.

PATIENTS AND METHODS

All consecutive patients who underwent abdominoperineal resection or pelvic exenteration and immediate reconstruction with a pedicled VRAM or thigh flap between September 1, 1993, and February 9, 2007, were identified using a prospectively maintained departmental database. Patients in the thigh flap group underwent an anterolateral thigh, gracilis myocutaneous, or posterior thigh flap procedure. Patients were excluded if they underwent both thigh and VRAM flap reconstruction, had a muscle-only rectus abdominis or gracilis flap, or had a free flap. This study was approved by The University of Texas M. D. Anderson Cancer Center Institutional Review Board.

Fifteen surgical oncologists performed the tumor resections, and 17 plastic surgeons performed the reconstructions. Surgical techniques used for ablative and reconstructive procedures remained relatively standardized over the period studied. The pelvic exenteration and abdominoperineal resection techniques[15] and VRAM harvest, inset, and donor-site closure techniques[6] have been described previously. Patient and surgeon preference, flap availability, and previous abdominal surgical history determined the choice of flap used. After surgery, patients were followed weekly until healed, then every 3 months for the first year, and then every 6 months for the second year. Follow-up included serial physical examination and review of interval computed tomographic scans obtained for oncologic surveillance.

Data on patient demographics, diagnosis, surgery, and other treatments; donor- and recipient-site complications; and follow-up were obtained from the prospectively maintained departmental database and retrospective review of each patient's medical record. Patient- and treatment-related variables were defined as follows. Body mass index was determined by the standard formula [weight in kilograms/(height in meters)^2], and obesity was defined as a body mass index of 30 or greater.[16] Comorbidities included all those listed in the medical record of the patient at the time of the initial presentation to M. D. Anderson. Patients were categorized as current smokers, previous smokers (quit ≥6 months before surgery), or never smokers. The American Joint Committee on Cancer staging system was used to determine the pathologic disease stage for each tumor.[17] The preoperative radiotherapy dose was the total cumulative dose delivered to the pelvis before surgery. Operative time included the total duration of resection and reconstruction. Length of follow-up was measured from the date of surgery to the date of the last patient visit to M. D. Anderson.

Postoperative complications were categorized as donor-site, recipient-site, and other (including medical) complications. Hematoma and seroma were considered complications when they required percutaneous and/or open drainage. Cellulitis was defined as a diffuse, nonsuppurative inflammation of the skin and subcutaneous tissue with or without associated lymphangitis,[18] and local wound infection was defined as focal cutaneous inflammation of the wound edges with suppuration but no dominant fluid collection[18]; both of these required antibiotic treatment alone. Minor wound dehiscence was defined as separation of wound edges involving less than one-third of the incision length and was treated with dressing changes only. Major wound dehiscence was defined as wound edge separation involving one-third or more of the incision length and was treated using negative-pressure wound therapy and/or secondary surgical wound closure. An incisional, perineal, or parastomal hernia was de-

fined as a palpable bulge identified on postoperative physical examination and/or computed tomography. Partial flap loss was defined as flap necrosis involving less than one-third of the flap volume and required only bedside debridement and/or dressing changes. Total flap loss was defined as flap necrosis of one-third or more of the flap volume and required operative debridement. Both donor- and recipient-site wounds were considered healed when wound edges were completely opposed in the absence of local wound infection, dehiscence, and underlying fluid collection. Delayed healing was defined as a wound without complete opposition of its edges by 2 weeks postoperatively. The diagnosis of bowel obstruction was made from clinical and radiographic examination.

For statistical analysis, recipient-site complications were pooled, as were donor-site complications. *Fluid collections* were collections that required percutaneous or open drainage, including seroma, hematoma, and abscess. *Major complications* included abscess at recipient or donor sites, major wound dehiscence at donor or recipient sites, total flap loss, and/or bowel obstruction. *Minor complications* included recipient- and donor-site hematoma, seroma, local wound infection, cellulitis, minor dehiscence, partial flap loss, and urinary tract infection. *Any complication* included all donor- and recipient-site complications along with medical and other complications.

The Wilcoxon rank sum test was used to compare continuous variables between flap groups; chi-square or Fisher's exact test was used to compare nonparametric variables between groups. For multicategorical data, Fisher's ($2 \times n$) tests were used to assess the independence of associations between variables and outcomes. Multivariate logistic regression analysis was performed using stepwise selection and included all patient, tumor, and treatment variables. No correction was made for multiple testing. Values of $p < 0.05$ were considered significant. Statistical analysis was performed with SAS 9.1 software (SAS Institute, Inc., Cary, N.C.) and Microsoft Excel 2003 Office Professional Edition software (Microsoft Corp., Redmond, Wash.).

RESULTS

Patient and Tumor Characteristics

Nineteen patients received 21 thigh flaps: nine gracilis myocutaneous flaps (bilateral in two patients), eight anterolateral thigh flaps, and four posterior thigh flaps. VRAM flaps were performed in 114 patients.

Patient and tumor characteristics are listed in Table 1. There were no significant differences in mean age, smoking status, patient comorbidities, obesity, or mean body mass index between the two groups. The thigh flap group had fewer men (11 percent versus 37 percent; $p = 0.03$) and more patients with previous abdominal surgery (95 percent versus 61 percent; $p = 0.003$) than the VRAM flap group.

The distributions of tumor types and stages were similar in the two groups (Table 1). The most common tumor type was rectal adenocarcinoma (58 percent and 66 percent of tumors in the thigh and VRAM flap groups, respectively). Similar proportions of patients in the two groups had recurrent tumors (53 percent and 41 percent of thigh and VRAM flap patients, respectively).

The mean length of follow-up was similar in the two groups (21.8 ± 17.0 months and 24.2 ± 20.6 months for the thigh and VRAM flap groups, respectively) ($p = 0.78$).

Treatment Characteristics

Treatment characteristics are summarized in Table 1. There was no significant difference between the groups in the use or dose of preoperative or intraoperative radiotherapy, the percentage of patients who underwent pelvic exenteration versus abdominoperineal resection, or the distribution of pelvic exenteration types. There were no differences in the relative proportion of patients who underwent colostomy versus ileostomy bowel diversion, the mean total operative time, or the mean operative blood loss between the two groups.

Surgical Outcomes

Surgical outcomes are summarized in Table 2. The mean hospital stay for thigh flap patients (20.0 ± 15.9 days) was 61 percent longer than for VRAM flap patients (12.4 ± 8.7 days); however, the difference was not quite significant ($p = 0.06$). Significantly more patients had delayed donor-site wound healing in the thigh flap group (37 percent) than in the VRAM group (16 percent) flap ($p = 0.03$). Although the mean time to recipient-site wound healing was 61 percent longer in the thigh flap group than in the VRAM flap group, the difference did not reach significance ($p = 0.09$).

Complications

Donor-site, recipient-site, and other complications are listed in Table 3. The only significant

Table 1. Univariate Analysis of Patient, Tumor, and Treatment Characteristics*

Characteristic	Thigh Flap (n = 19) (%)	VRAM Flap (n = 114) (%)	p
Mean age, years	63.0 ± 8.5 yr	58.0 ± 12.0 yr	0.08†
Male sex	2 (10.5)	42 (36.8)	0.03‖
Mean BMI	26.0 ± 5.2	27.1 ± 6.8	0.40‡
Obesity (BMI ≥30)	3 (15.8)	28 (24.6)	0.56‖
Comorbidities			
Diabetes mellitus	4 (21.1)	11 (9.6)	0.23‖
Coronary artery disease	1 (5.3)	8 (7.0)	1.00‖
Hyperlipidemia	1 (5.3)	12 (10.5)	0.69‖
Hypertension	9 (47.4)	42 (36.8)	0.38§
Congestive heart failure	1 (5.3)	3 (2.6)	0.46‖
Genetic cancer mutations	2 (10.5)	3 (2.6)	0.15‖
Previous abdominal surgery	18 (94.7)	69 (60.5)	0.003§
Smoking status			0.10
Never smoker	12 (63.2)	62 (54.4)	0.48§
Previous smoker	1 (5.3)	29 (25.4)	0.07‖
Current smoker	6 (31.6)	23 (20.2)	0.26§
Diagnosis			0.37†
Rectal adenocarcinoma	11 (57.9)	75 (65.8)	
Anal SCC	4 (21.1)	16 (14.0)	
Prostate adenocarcinoma	1 (5.3)	9 (7.9)	
Transitional cell/bladder adenocarcinoma	1 (5.3)	10 (8.8)	
Vaginal/vulvar SCC	2 (10.5)	2 (1.8)	
Other	0	2 (1.8)	
Stage (AJCC)			0.91‖
0	0	3 (2.6)	
I	0	8 (7.0)	
II	6 (31.6)	34 (29.8)	
III	10 (52.6)	49 (43.0)	
IV	3 (15.8)	20 (17.5)	
Recurrent tumor	10 (52.6)	47 (41.2)	0.31§
Mean length of follow-up, months	21.8 ± 17.0	24.2 ± 20.6	0.78‡
Median length of follow-up, months	19.0	18.0	
Chemotherapy (preoperative)	14 (73.7)	105 (92.1)	0.03§
Radiotherapy			
Preoperative	18 (94.7)	97 (85.1)	0.47§
Mean preoperative dose, Gy	52.9 ± 15.3	51.7 ± 12.2	0.75†
Intraoperative	7 (36.8)	33 (28.9)	0.49§
Mean intraoperative dose, Gy	11.8 ± 2.4	13.4 ± 6.9	0.60†
Surgery type			0.77§
Abdominoperineal resection	7 (36.8)	46 (40.4)	
Pelvic exenteration	12 (63.2)	68 (59.6)	
Anterior	1 (5.3)	8 (7.0)	1.00‖
Posterior	4 (21.1)	35 (30.7)	0.59§
Total	7 (36.8)	23 (20.2)	0.12§
Composite	0	2 (1.8)	1.00‖
Partial vaginectomy	7 (36.8)	25 (21.9)	0.16§
Total vaginectomy	10 (52.6)	43 (37.7)	0.22§
Other surgical procedures			
Urinary diversion, ileal conduit	8 (42.1)	34 (29.8)	0.25§
Bowel diversion, colostomy	16 (84.2)	97 (85.1)	1.16§
Bowel diversion, ileostomy	1 (5.3)	9 (7.9)	1.00‖
Mean total operative time, minutes	316.1 ± 214.1	297.1 ± 174.3	0.95‡
Mean estimated total blood loss, ml	1806.9 ± 1827.0	1243.1 ± 1126.5	0.28†

BMI, body mass index; SCC, squamous cell carcinoma; AJCC, American Joint Committee on Cancer.
*Data are number of patients (%) unless otherwise indicated. Means are given with standard deviations.
†Wilcoxon rank sum test.
‡t test.
§χ^2 test.
‖Fisher's exact test.

differences in donor-site complications were the increased incidence of cellulitis (26 percent versus 6 percent; $p = 0.01$) and fluid collection (37 percent versus 7 percent; $p = 0.0001$) in the thigh group versus the VRAM flap group.

Numerous recipient-site complications occurred more commonly in the thigh flap patients than in the VRAM flap patients: local wound infection (26 percent versus 5 percent; $p = 0.01$), cellulitis (21 percent versus 4 percent; $p = 0.02$),

Table 2. Surgical Outcomes*

Outcome	Thigh Flap (n = 19) (%)	VRAM Flap (n = 114) (%)	p
Length of stay, days	20.0 ± 15.9	12.4 ± 8.7	0.06§
Donor-site healing time, weeks	3.4 ± 6.1	1.9 ± 5.0	0.08‡
Donor-site, delayed healing†	7 (36.8)	18 (15.8)	0.03‖
Recipient-site healing time, weeks	11.6 ± 17.4	7.2 ± 15.0	0.09‡
Recipient-site, delayed healing†	11 (57.9)	43 (37.7)	0.10‖
Alive at last planned follow-up	17 (89.5)	111 (97.4)	0.15‖

*Data are number of patients (%) or mean ± SD.
†Delayed healing defined as >2 wk.
‡Wilcoxon rank sum test.
§t test.
‖χ^2 test.

Table 3. Complications*

Complication	Thigh Flap (n = 19) (%)	VRAM Flap (n = 114) (%)	p
Donor site			
Hematoma	2 (10.5)	2 (1.8)	0.10
Seroma	4 (21.1)	6 (5.3)	0.12
Abscess	1 (5.3)	4 (3.5)	0.54
Fluid collection	7 (36.8)	8 (7.0)	0.0001†
Local wound infection	1 (5.3)	4 (3.5)	0.54
Cellulitis	5 (26.3)	7 (6.1)	0.01
Hernia, incisional‡	0	4 (3.5)	1.00
Hernia, parastomal‡	0	8 (7.0)	0.60
Dehiscence, minor	0	13 (11.4)	0.21
Dehiscence, major	1 (5.3)	3 (2.6)	0.46
Other donor-site complications§	0	8 (7.0)	0.60
Recipient site			
Hematoma	0	0	0
Seroma	3 (15.8)	7 (6.1)	0.15
Abscess	6 (31.6)	7 (6.1)	0.0005†
Fluid collection	9 (47.4)	14 (12.3)	0.0002
Local wound infection	5 (26.3)	6 (5.3)	0.01
Cellulitis	4 (21.1)	5 (4.4)	0.02
Hernia, perineal	0	1 (0.9)	1.00
Dehiscence, minor	6 (31.6)	37 (32.5)	0.94†
Dehiscence, major	4 (21.1)	6 (5.3)	0.04
Flap loss, partial	3 (15.8)	6 (5.3)	0.12
Flap loss, total	1 (5.3)	1 (0.9)	0.27
Other recipient-site complications‖	6 (31.6)	5 (4.4)	0.001
Other			
Urinary tract infection	3 (15.8)	11 (9.6)	0.42
Small bowel obstruction	2 (10.5)	6 (5.3)	0.32
Miscellaneous complications¶	5 (26.3)	25 (21.9)	0.77
Pooled complications			
Any donor-site complication	8 (42.1)	33 (29.0)	0.25†
Any recipient-site complication	16 (84.2)	59 (51.8)	0.01†
Any complication#	16 (84.2)	82 (71.9)	0.40†
Minor complication	14 (73.7)	65 (57.0)	0.17†
Major complication	8 (42.1)	17 (14.9)	0.005†
≥Two major complications	6 (31.6)	4 (3.5)	0.006

*Data are number of patients (%).
†χ^2 test used; all other statistical comparisons performed with Fisher's exact test.
‡Hernia formation evaluated for abdominal wall in the thigh flap group.
§Other donor-site complications included hypertrophic scarring, fat necrosis, and partial-thickness umbilical necrosis.
‖Other recipient-site complications included hypertrophic scarring, vaginal stenosis, and fistula (vesicovaginal or vaginocutaneous).
¶Miscellaneous complications were unrelated to the donor and recipient sites and included cardiac, pulmonary, thromboembolic, neurologic, and other medical complications.
#Includes all donor- and recipient-site complications, and other complications.

pelvic abscess (32 percent versus 6 percent; p = 0.0005), fluid collection (47 percent versus 12 percent; p = 0.0002), and major wound dehiscence (21 percent versus 5 percent; p = 0.04).

When all major and minor postoperative complications were pooled, the overall complication rate was high in both groups: 84 percent in the thigh flap group versus 72 percent in the VRAM

flap group ($p = 0.4$) (Table 3). The overall donor-site and overall recipient-site complication rates were both greater in the thigh versus VRAM flap groups, but only the difference in recipient-site complications reached statistical significance (84 percent versus 52 percent; $p = 0.01$). Patients in the thigh flap group were more likely to have at least one major complication (42 percent versus 15 percent; $p = 0.005$) and two or more major complications (32 percent versus 4 percent; $p = 0.0006$).

Factors Associated with and Independently Predictive of Complications

Any Complications

In a univariate analysis, factors identified to be associated with any complication included female sex, greater body mass index, previous abdominal surgery, and performance of a bowel diversion (ileostomy or colostomy) (all $p \leq 0.02$; data not shown). In addition, the hospital stay was longer in patients with any complication than in those without complications ($p = 0.002$). In the multivariate logistic regression analysis (Table 4), the only independent predictor of the occurrence of any complication was previous abdominal surgery (odds ratio, 3.6; $p = 0.005$). Stage I disease was an independent protective factor against the development of any complication (odds ratio, 0.16; $p = 0.03$).

Donor-Site Complications

Factors associated with an increased risk for donor-site complications were greater body mass index, obesity, longer hospital stay, and longer donor-site healing time (all $p \leq 0.02$; data not shown). In the multivariate logistic regression analysis (Table 4), obesity was the only independent predictor of any donor-site complication (odds ratio, 3.3; $p = 0.01$).

Recipient-Site Complications

Factors associated with an increased risk of recipient-site complications were female sex ($p = 0.03$), previous abdominal surgery ($p = 0.003$), stage IV disease ($p = 0.02$), posterior vaginectomy ($p = 0.01$), use of a thigh flap ($p = 0.01$), and bowel diversion ($p = 0.02$; data not shown). Anterior pelvic exenteration was associated with fewer recipient-site complications than other types of pelvic exenteration ($p = 0.04$). In addition, patients with recipient-site complications had a longer hospital stay ($p = 0.03$) and longer healing time at both donor and recipient sites ($p \leq 0.002$). The multivariate logistic regression analysis (Table 4) identified previous abdominal surgery as an independent predictor of any recipient-site complication (odds ratio, 3.5; $p = 0.002$) and never smoking status as an independent protective factor against recipient-site complications (odds ratio, 0.6; $p = 0.03$).

Major Complications

Factors associated with an increased risk of major complications were use of a thigh flap ($p = 0.02$), longer donor-site ($p = 0.0002$) and recipient-site ($p = 0.0003$) healing times, and posterior vaginectomy ($p = 0.04$; data not shown). The only independent predictor of any major complication was previous abdominal surgery (odds ratio, 3.6; $p = 0.005$), and the only independent protective factor against major complications was stage I disease (odds ratio, 0.16; $p = 0.03$) (Table 4).

Minor Complications

Factors associated with an increased risk of minor complications were greater body mass index, obesity, previous abdominal surgery, bowel diversion, prolonged donor- and recipient-site healing times, and longer hospital stay (all $p < 0.05$; data not shown). Multivariate logistic regression analysis identified greater body mass index as an independent predictor of any minor complication (odds ratio, 1.13; $p = 0.004$) (Table 4).

Table 4. Independent Predictors of Complications in Multivariate Logistic Regression Analysis

Complication	Factor	OR	95% CI	*p*
Any	Previous abdominal surgery	3.6	1.48–8.8	0.005
	Stage I disease	0.16	0.03–0.85	0.03
Any donor-site	Obesity	3.3	1.37–7.8	0.01
Any recipient-site	Previous abdominal surgery	3.5	1.6–7.9	0.002
	Never smoking	0.6	0.4–0.9	0.03
Any major	Previous abdominal surgery	3.6	1.5–8.8	0.005
	Stage I disease	0.16	0.03–0.85	0.03
Any minor	Greater BMI	1.13	1.04–1.22	0.004

OR, odds ratio; CI, confidence interval; BMI, body mass index.
A total of 43 variables were initially introduced into each individual stepwise regression model. Regression analysis performed on final variables with values of $p \leq 0.10$ (range, two to nine variables) yielded identical results.

DISCUSSION

The goal of this study was to directly compare the surgical outcomes and complications in cancer patients undergoing pedicled thigh versus VRAM flaps for immediate reconstruction of abdominoperineal resection and pelvic exenteration defects. Our original hypothesis was partially validated: VRAM flaps resulted in better surgical outcomes and fewer major complications than pedicled thigh flaps. However, there was no significant increase in abdominal wall morbidity with VRAM flaps.

This study demonstrated that thigh flaps have significantly higher rates of major complications, including major wound dehiscence and pelvic abscess, than VRAM flaps. Furthermore, thigh flap donor sites have higher rates of infection and take longer to heal than VRAM flap donor sites. Thigh flap recipient sites also have higher rates of infection, wound dehiscence, and longer healing times than VRAM flap recipient sites. We thus believe that VRAM flaps, when available, should be the first choice for immediate reconstruction of abdominoperineal resection and pelvic exenteration defects. Thigh flaps are useful when VRAM flaps are unavailable or unfavorable and when delayed or salvage reconstruction of perineal/pelvic wounds is performed and access through the abdominal wall and pelvis is undesirable. Thigh flaps may be a better primary option for immediate reconstruction when there are existing ostomies through both rectus muscles, a VRAM flap has been previously used, and/or previous incisions preclude the reliability of a VRAM flap.

High complication rates have been reported with primary suture closure of both abdominoperineal resection (25 to 60 percent)[1,6,19–22] and pelvic exenteration defects (32 to 84 percent),[4,11,15] and flap reconstruction of these defects has been shown to decrease the rates of major complications.[1,6,9–11,19–24] The current study demonstrated a 15 percent rate of major complications for VRAM flap reconstruction, which compares favorably with the 15 to 22 percent rates reported in the literature.[1,4,12] In addition to having lower wound healing complication rates, VRAM flaps did not have increased early abdominal wall morbidity despite harvest of skin, fascia, and rectus abdominis muscle from the abdomen. The thigh flap group (having a laparotomy and transabdominal tumor resection) served as a control for any potential increased abdominal wall donor-site morbidity resulting from VRAM flap harvest. Careful follow-up, including computed tomographic scans obtained for oncologic surveillance, was used to identify abdominal wall complications. During the mean 24.2-month follow-up, the incidence of hernias was relatively low despite VRAM flap harvest; however, it is possible that hernias might occur at higher rates after the follow-up period in the VRAM flap patients. Long-term studies will be helpful to quantify the "true," late abdominal wall morbidity following VRAM flap harvest.

Thigh flaps in our study had high rates of major (42 percent) and minor (74 percent) complications. Although these rates appear higher than some rates reported in the literature, the difference is likely attributable to variations in the way "major" and "minor" complications are defined. In their study of reconstructions of 25 abdominoperineal resection and pelvic exenteration defects with pedicled gracilis myocutaneous flaps (only seven of which were immediate reconstructions), Vermaas et al.[25] reported major and minor complication rates of 43 percent and 0 percent, respectively; however, only infection, abscess, hernia, and fistula were included in that analysis. Shibata et al., reporting their experience with 16 abdominoperineal resection and pelvic exenteration patients undergoing immediate bilateral gracilis myocutaneous flap reconstruction,[11] found a major complication rate of 12 percent; that rate included only patients with pelvic abscess requiring hospitalization, surgical revision, or both. Minor complications, defined as persistent perineal fistulas and subcutaneous abscesses, occurred in 25 percent of patients. Other complications, such as wound healing problems, dehiscence, flap loss, seroma, hematoma, or abnormal scarring, were not included. Pusic and Mehara, in a report on the use of bilateral gracilis myocutaneous flaps to repair total vaginal defects, commonly seen after pelvic exenteration,[10] identified a 10 percent risk of pelvic abscess and a 10 to 20 percent incidence of skin loss.[10] Given the variations in determination of complication rates, it is likely that some complications were underreported in earlier studies.

To our knowledge, ours is the largest study to evaluate flap reconstruction of perineal/pelvic defects following cancer resection and the first to directly compare the outcomes of thigh and VRAM flaps for abdominoperineal resection or pelvic exenteration reconstruction. The strengths of this study include a comprehensive analysis of complications in both groups; prospective entry of patient, treatment, and outcome data into a central database; similar surgical techniques used in the patients studied; a long follow-up for patients in both the thigh and VRAM flap groups (mean,

22 and 24 months, respectively); and the multivariate logistic regression analysis to identify independent predictive and protective factors for the development of complications. The potential limitations of the study include its retrospective nature and the relatively small number of thigh ($n = 19$) compared with VRAM flaps ($n = 114$). The smaller number of thigh flaps in our series likely resulted from our initial feeling that VRAM flaps would result in better outcomes and caused a bias in flap selection. Despite the difference in size of the flap groups, however, they were similar in most patient, tumor, and treatment characteristics, and all significant differences in complications between the two groups favored the VRAM flap group. We anticipated that previous abdominal surgery would be a relative indication to use a thigh rather than VRAM flap for reconstruction, so the higher incidence of previous abdominal surgery in the thigh flap group was not surprising.

Interestingly, perioperative radiotherapy was not an independent predictor of recipient-site complications in this analysis; however, only 18 of the 133 patients (14 percent) in the study did not receive preoperative radiotherapy, and this relatively small number may have precluded the ability to identify differences in complications by radiotherapy status, if such differences exist.

Some risk factors for complications—for example, obesity and tobacco use—can be altered preoperatively in the hope of improving outcomes. Although weight loss and tobacco cessation may be difficult for patients with a newly diagnosed or recurrent malignancy, such changes may be possible for patients who undergo neoadjuvant chemotherapy and/or radiotherapy before surgery. Regardless, identification of factors that are protective against or predictive for the development of specific complications is useful to surgeons for patient and technique selection and counseling patients about outcome expectations.

CONCLUSIONS

VRAM flaps are associated with fewer complications than thigh flaps when used for immediate reconstruction of abdominoperineal resection and pelvic exenteration defects and do not increase early abdominal wall morbidity. VRAM flaps, if available, should be the first choice for immediate reconstruction of perineal/pelvic defects following abdominoperineal resection and pelvic exenteration.

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CODING PERSPECTIVE

This information prepared by Dr. Raymond Janevicius is intended to provide coding guidance.

15734	VRAM (myocutaneous flap of trunk)
15738	Thigh flap (muscle, myocutaneous, or fasciocutaneous flap of lower extremity)

- The pedicled muscle and fascial flap codes (15732, 15734, 15736, and 15738) are reported by *donor site* of the flap. Thus, the rectus abdominis flaps are reported with code 15734, and the thigh flaps are reported with code 15738.
- The 1573X series reads: "Muscle, Myocutaneous, or fasciocutaneous flap." Each of the axial pattern thigh flaps is reported with the same code, 15738.
- This series of codes includes the following:
  - Elevation of the flap with dissection of the muscle and/or fascia, including disoriginating and/or disinserting the flap
  - Preservation of axial blood supply, including dissection of artery and vein
  - Inclusion of overlying skin and subcutaneous tissue in myocutaneous and fasciocutaneous flaps
  - Transfer and inset of flap
  - Direct closure of donor site

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