INTRODUCTION

Radical pelvic gynecologic oncologic surgery results in large vaginal and pelvic defects; combining these extirpative procedures with vaginal and pelvic floor reconstruction is being performed with increasing frequency. Several publications have shown the benefits of pelvic reconstruction including sexual rehabilitation, pelvic floor support, improved quality of life and body image, improved primary healing, and reduced rates of intestinal complications. Although the benefits of pelvic reconstruction have been well discussed, long-term outcomes and complications of reconstructive techniques are infrequently studied. Although the type of flap used for reconstruction is a subject of much discussion and a classification system based on defect size and location has been put forth, a clear evidence-based reconstructive algorithm does not yet exist. The aim of this study was to perform a comprehensive retrospective study of consecutive cases of pelvic reconstruction following gynecologic oncologic resection and determine if outcomes are dependent on patient factors and type of reconstruction performed. This series also represents one of the largest series in the literature of pelvic reconstruction with locoregional flaps after gynecologic resection. Our objective was to explore the patient and surgical factors impacting complication rate, reoperation rate, and length of stay (LOS) with the goal of better informing the preoperative discussion with the patient and family regarding expected surgical outcomes and hospital stay.

Background: Defects resulting from gynecologic oncology resections can range from small external defects to total exenterations, requiring complex pelvic reconstruction. We aim to investigate the patient and surgical factors that influence complication rates, reoperation rates, and length of stay. We hypothesize that this patient cohort will have high complication and reoperation rates that are likely most affected by their medical and extirpative surgery factors, with less direct impact from their reconstructive surgery procedures.

Methods: All cases of reconstruction following resection of a gynecologic oncology tumor at the University of Wisconsin Hospital over the last 14 years were reviewed. Forty-three patients were identified who required 66 flaps for reconstruction.

Results: Mean follow-up period was 19 months. Overall complication rate was 65% and reoperation rate was 33%. Plastic surgery flap-specific complication and reoperation rates were 47% and 19%, respectively, and were not significantly associated with any patient risk factors. Flap reconstruction subtype was not associated with time to complete healing, complication rate, or reoperation. Prior chemotherapy was significantly correlated with increased rate of overall complication (P = 0.0253) and reoperation (P = 0.0448), but prior radiation was not. Mean hospital stay was 11 days (SD ± 9 d). Factors found to be significantly associated with an increase in hospitalization length were increasing number of comorbidities (P = 0.021), exenteration defects (P = 0.0122), myocutaneous flap reconstruction (P = 0.0003), radiation (P = 0.0004), and chemotherapy (P = 0.0035).

Conclusion: This patient cohort has an overall high complication and reoperation rate; however, increasingly complex reconstruction is not associated with significant differences in complication rates or reoperation.

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hospitalization course. These are often extensive extirpation operations requiring complex reconstruction with a long postoperative course and relatively high complication and reoperation rate. Ultimately, our goal was to provide data for a more complete informed consent process with the patient.

**METHODS**

A retrospective review of all patients treated at University of Wisconsin between 1999 and 2013 was performed utilizing electronic medical record review after approval by the institutional review board. Inclusion criteria was flap reconstruction with a pedicled flap following extirpative surgery resulting in a gynecologic defect. Defect location was classified as perineal (involving the external structures of the vulva and/or perineal body), vaginal (including both partial and circumferential), and exenteration (removal of central pelvic organs of the uterus, cervix, partial or total vaginectomy, with addition of anterior organs including bladder and urethra +/- ureters, and/or posterior organs including rectosigmoid +/- anus), or a combination.

Wound complications were defined as minor or major, and classified as donor or recipient-site complications. Minor complications consisted of superficial wound dehiscence, infection treated as an outpatient, vaginal stenosis, or seroma. Major complications included ventral hernia, abscess, hematoma, infection requiring hospitalization, enterocutaneous fistula, wound requiring reoperation, vaginal fistula, and partial or complete flap loss. Flap-specific complications were defined as direct complications of either the flap or the donor-site harvest.

Patients received pelvic rest for 8 weeks following vaginal reconstruction. If perineal reconstruction was performed, patients were prohibited from sitting for 2 weeks to avoid additional pressure on the reconstruction site.

**Statistical Methods**

Continuous outcomes were compared between groups using Wilcoxon rank sums tests; their association with other continuous variables were evaluated with correlation coefficients. Complication and reoperation rates were estimated using Kaplan and Meier tests and compared between groups using a log-rank test. Cox proportional hazards models were used to assess the impact of continuous variables on these rates. Fisher’s exact tests were employed to examine the relationship between 2 categorical variables. All analyses were performed using SAS statistical software version 9.4 (SAS Institute Inc., Cary, N.C.). \( P \) values less than 0.05 were considered to be statistically significant.

**RESULTS**

**Demographics**

From January 1999 to January 2014, 43 female patients, average age 56 years, with acquired defects from oncologic resection underwent reconstruction using a variety of locoregional pedicled flaps (Table 1). Average body mass index was 28 kg/m² and a majority (63%) were nonsmokers. Forty-four percentage of patients had no comorbidities; 9% presented with greater than 3. Seventy-seven percentage of patients had previous abdominal surgery.

Table 1. Characteristics (n = 43)

| Characteristics                              | n (%) |
|---------------------------------------------|-------|
| Age (y) (mean ± SD)                         | 56±16 |
| Body mass index (kg/m²) (mean ± SD)        | 28±8  |
| Comorbidities                               |       |
| 0                                           | 19 (44) |
| 1                                           | 9 (21)  |
| 2                                           | 9 (21)  |
| 3                                           | 4 (9)   |
| Previous abdominal surgery                  |       |
| Yes                                         | 33 (77) |
| No                                          | 16 (37) |
| Smoking history                             |       |
| Yes                                         | 27 (63) |
| No                                          | 16 (37) |
| Tumor pathology                            |       |
| Vulvar squamous cell                        | 23 (53) |
| Rectal adenocarcinoma                       | 9 (21)  |
| Vaginal squamous cell                       | 2 (5)   |
| Endometrioid adenocarcinoma                 | 2 (5)   |
| Cervical adenocarcinoma                     | 2 (5)   |
| Bartholin adenocarcinoma                    | 1 (2)   |
| Anal squamous cell                          | 1 (2)   |
| Mucinous adenocarcinoma                     | 1 (2)   |
| Recurrent tumors                            | 11 (26) |
| Preoperative chemotherapy                   | 21 (49) |
| Preoperative radiotherapy                   | 31 (72) |
| Dose (Gy) (mean ± SD)                       | 61±17  |
| Nononcologic pathologies                    |       |
| Unstable vaginal cuff                       | 1 (2)   |
| Ulcerative colitis                          | 1 (2)   |

**Surgical Factors**

Preoperative patient characteristics that were not associated with higher rate of complications or reoperation included recurrent tumor, number of comorbidities, age, body mass index (BMI), smoking history, and prior abdominal surgery. A higher number of comorbidities was found to be significantly associated with longer hospitalization \( (P = 0.021) \). There was no significant association between number of comorbidities and likelihood of requiring intensive care unit level care during the postoperative hospitalization.

**Patient Factors and Outcomes**

Preoperative patient characteristics that were not associated with higher rate of complications or reoperation included recurrent tumor, number of comorbidities, age, body mass index (BMI), smoking history, and prior abdominal surgery. A higher number of comorbidities was found to be significantly associated with longer hospitalization \( (P = 0.021) \). There was no significant association between number of comorbidities and likelihood of requiring intensive care unit level care during the postoperative hospitalization.

**Table 1. Characteristics (n = 43)**
9.63 days, \( P = 0.0122 \)), but was not associated with longer time to definitive healing, or increased complication or reoperation rates.

Forty percentage of patients underwent simultaneous colostomy, 16% underwent ileostomy, and 19% underwent urostomy. Colostomy was associated with significantly longer LOS (17.0 versus 6.88 days, \( P < 0.0001 \)). The absence of fecal or urinary diversion being performed was not found to be significantly associated with reduced complication or reoperation rates.

Reconstructive techniques were varied and often utilized in combination depending on the defect. All flaps were pedicled locoregional flaps; no free flaps were required. Overall, the vertical rectus abdominis myocutaneous (VRAM) flap (Fig. 1) was the most commonly utilized (40%), followed by bilateral thigh fasciocutaneous flaps (21%; Figs. 2, 3), bilateral gracilis myocutaneous flaps (19%; Fig. 4), unilateral thigh fasciocutaneous flap (16%), unilateral gracilis myocutaneous flap (12%), and omentum (2%). Fasciocutaneous flaps utilized were either “Singapore” flaps, rotation flaps, advancement flaps, random pattern fasciocutaneous flaps, or V to Y flaps; there were no ALT flaps utilized in this series. Flap choice was dependent on surgeon judgment, given the extirpation defect, goals of the patient, available donor sites, and patient body habitus.

### Hospital Course
Following surgery, mean hospital stay was 11 days (SD ± 9 d). Both preoperative radiation and preoperative chemotherapy were associated with a longer LOS (13.23 versus 5.67 days, \( P = 0.0004 \) and 15.05 versus 7.36 days, \( P = 0.0035 \), respectively). Additional factors associated with a significant increase in LOS were increasing number of comorbidities (\( P = 0.021 \)), exenteration defects (14.54 versus 9.63 days, \( P = 0.0122 \)), simultaneous colostomy (17.0 versus 6.8 days, \( P < 0.0001 \)), myocutaneous flap reconstruction (14.19 versus 5.5 days, \( P = 0.0003 \)), and development of a wound complication while still hospitalized (20.69 versus 6.97 days, \( P < 0.0001 \)).

![Fig. 1. Vertical rectus abdominis myocutaneous flap. A, Flap design of left VRAM. B, Flap raised and ready for tunneling to the perineal defect. C, Flap inset to resurface perineal defect.](image-url)
Overall Complication and Reoperation Rate

Sixty-five percentage of patients experienced a complication (total of 34 complications; Table 3). The majority of complications were minor (71%). Half of all complications consisted of partial wound dehiscence at the recipient site (50%). Overall, recipient-site complications occurred more frequently (56%) than donor-site complications (16%). Wound complications occurring while still inpatient, which occurred 30% of the time, were associated with longer hospitalization (20.69 versus 6.97 days, \( P < 0.0001 \)) but were not associated with increased overall time to complete healing. The majority of complications occurred within 30 days (59%); of these, the majority were minor (75%), and consisted primarily of dehiscence at the donor or recipient site (75%). Complications after 30 days consisted of dehiscence of the donor or recipient site (n = 5), vaginal stenosis (n = 2), fistula (n = 1), and osteomyelitis of the coccyx (n = 1).

Presence of a postoperative complication was significantly correlated with preoperative chemotherapy (overall complication rate 90% versus 50%, \( P = 0.0253 \); 30-day complication rate 59.1% versus 39.3%) but, notably, not with prior radiation therapy. Preoperative chemotherapy was significantly correlated with an increased reoperation rate overall (50% versus 19.05%), as well as a 30-day reoperation rate (20.32% versus 4.77%, \( P = 0.0448 \)), but, again, preoperative radiation therapy was not. Interestingly, we also identified that a history of depression was associated with a significantly higher risk of reoperation overall (62% versus 15%), as well as 30-day reoperation rate (22.23% versus 4.77%, \( P = 0.0118 \)). Additional factors that were not significantly related to development of postoperative complications or reoperation include recurrent tumor, number of comorbidities, age, BMI, prior abdominal surgery, smoking history, type of defect, and type of flap reconstruction. Conversely, fecal or urinary diversion was not protective against complication or reoperation.

Flap-specific Complication and Reoperation Rate

Flap-specific complications and reoperations were defined as donor- or recipient-site complications or reoperations that were not attributable to pathology recurrence, enterocutaneous fistula, diversion complication, or pelvic abscess. Flap-specific complication rate was 47%; 85% of those were minor. Eighty-five percentage of these patients had recipient-site complications, 25% had donor-site complications, and 10% had both. Flap-specific reoperation rate was 19%. Flap-specific complications were not found to be statistically significantly associated with age, comorbidities, presence of rectal tumor, prior abdominal surgery, smoking history, prior chemotherapy or radiation therapy, diversion, type of defect, or type of flap.

Flap type was associated with variable LOS. Myocutaneous flaps were associated with significantly longer LOS (14.19 days) when compared with fasciocutaneous flaps (5.5 days) or a combination of myocutaneous and fasciocutaneous flaps (9.0 days; \( P = 0.0003 \)). Specifically, rectus (14.06 days) and bilateral gracilis (18.63 days) myocutaneous flaps correlated with significantly longer hospitalizations (\( P = 0.0447 \) and \( P = 0.002 \)), while both unilateral
(4.86 days) and bilateral (6.78 days) fasciocutaneous flaps were correlated with significantly shorter hospitalizations ($P = 0.0076$ and $P = 0.0418$). Time to complete healing, complication rate, and reoperation rate were not affected by flap selection type.

Some flap types were significantly associated with defect type. Specifically, rectus myocutaneous flap reconstruction had a significant association with exenteration defects ($P = 0.0018$) and vaginal defects ($P = 0.025$), while bilateral gracilis myocutaneous flaps reconstruction was significantly associated with exenteration defects ($P = 0.0415$). When grouping reconstruction into subtypes, vaginal defects had a significant association with myocutaneous flap reconstruction as opposed to fasciocutaneous flaps (88.89% versus 5.56%, $P = 0.0027$). Exenteration defects required either myocutaneous flap reconstruction alone (92.31%), or both myocutaneous and fasciocutaneous flap reconstruction (7.69%).

When reconstruction was evaluated based on the extent of flap reconstruction, having 2 or more flaps required for reconstruction of pelvic defects was associated with significantly longer LOS (19.67 versus 9.73 days, $P = 0.0139$). There was no difference in time to complete healing or complication rate when compared with patients who had a single flap used for reconstruction.

### Functional Outcomes

Complete healing time was an average of 5 months (SD ± 4 m); average follow-up time was 19 months (SD ± 24 m). Only 28% of patients had sexual function addressed during their postoperative course. When sexual function was discussed in the chart, 75% endorsed successful intercourse. This represents 21% of our total patient population reporting successful intercourse. Lastly, 30% of patients had died of their primary disease at the time of the chart review.

### DISCUSSION

Reconstructive options for perineal/vulvar defects have been extensively described in the literature, and algorithms for vulvar and vaginal reconstruction have been proposed. Vaginal reconstructive options found in the literature include VRAM flaps, deep inferior epigastric artery perforator flaps, propeller flaps, vascularized jejunum, superior and inferior gluteal artery perforator flaps, gracilis myocutaneous flaps, gluteal fold V-Y advancements, pudendal thigh (Singapore) flap as well as a variety of modifications. Several studies have shown the VRAM flap to be superior to other flap options be-
cause of bulk, adequate arc of rotation, and reliable vascular supply.6,20,29,30

In this study, there was no difference in complication rate, reoperation rate, or time to complete healing when comparing flap reconstruction subtypes. Patients who were reconstructed with myocutaneous flaps, or those requiring multiple flaps, required significantly longer hospitalizations but ultimately went on to heal and have similar complication and reoperation rates to those patients who required less extensive reconstructive procedures. This data can help inform preoperative counseling of patients when discussing expected length of hospitalization as well as overall course of recovery. Additionally, it defines for the patient and surgeon that there is not an increased risk of an adverse outcome associated with increasing complex reconstructive procedures.

It should also be noted that overall complication rates are high for this patient population, given their surgical and oftentimes medical complexity. The pelvis is fraught with difficulty in healing surgical wounds, due to its dependent position on the body, the support the pelvic floor must provide to internal organs, and its location as the junction between the trunk and extremities. When the data were evaluated to elucidate which complications were attributable to the plastic surgical portion of the procedure alone, both the complication and reoperation rates dropped markedly. This demonstrates that patients need to be appropriately counseled on the high overall risk of complication with this surgical undertaking, but that the reconstructive portion of their care accounts for a smaller relative proportion of that risk.

Pertinent factors found to impact length of hospitalization were preoperative chemotherapy and radiation, exenteration defects, simultaneous colostomy, and myocutaneous or multiple flap reconstructions. However, increasing age, BMI, and number of comorbidities were not significantly associated with an increased risk of complications, reoperation, or longer hospital stay. Additionally, patients who were active or recent smokers, or who had previous abdominal surgery were also not shown to be at increased risk of adverse events. These data indicate that it is safe to perform complex oncolgic and reconstructive surgery for these patients. Furthermore, patient factors should not preclude patients from receiving indicated extirpative and reconstructive surgery, but can allow for patient-specific preoperative counseling and risk assessment.

Interestingly, there was not a statistically significant protective effect of diversion procedures on complication rates, reoperation rates, or time to complete healing. This may be selection bias in that those patients who underwent simultaneous diversion procedures were evaluated preoperatively as being at higher risk of wound complication, given their specific clinical circumstance.

Gynecologic defects predominantly result from resection of a malignancy, and thus demonstrate a high rate of preoperative radiation therapy. Not surprisingly, several studies demonstrate radiation as a risk factor for poor healing and wound complications.20,21 Though an irradiated recipient bed is fraught with potential complications, this should not preclude reconstruction and in fact may induce improved outcomes by bringing in well-vascularized tissue. Notably, a previous study showed that immediate placement of VRAM flaps for irradiated abdominoperineal resection defects results in a lower incidence of perineal abscess, major perineal wound dehiscence, and drainage procedures than those closed primarily without a flap placement.21 In this study, we found that radiation therapy was not associated with an increased risk of delayed healing, wound complications, or reoperation rate. However, a majority of study patients underwent radiation therapy, and so our nonradiation group may have been under-powered to elucidate whether there was a statistical difference. Preoperative chemotherapy, meanwhile, was associated with significantly increased complication and reoperation rates. The increased risk of perineal wound complication after neoadjuvant chemotherapy has been reported elsewhere in the literature,42 indicating that patients who require neoadjuvant chemotherapy should be counseled preoperatively regarding their increased risk of postoperative complication and reoperation.

The assessment of sexual function requires directed queries. Overall, 21% of patients had achieved sexual intercourse postoperatively. However, discussions of sexual function are often limited and poorly documented pre- and postoperatively. When sexual function was specifically addressed with patients postoperatively, 75% reported successful intercourse. Given the high percentage of those patients who were asked about sexual function reporting successful intercourse, the overall low percentage in this study likely significantly underestimates the proportion of patients who successfully engage in sexual intercourse postoperatively. A recent study showed the most notable predictor of postoperative sexual intercourse following vaginal reconstruction was preoperative sexual intercourse.20 Reported rates of penile-vaginal intercourse after vaginal reconstruction range from 14% to 84.6%.5,20,32-39

Aside from inherent limitations of a retrospective chart review, there are additional limitations to this study. Internal controls such as patients who underwent resection but did not receive reconstruction were not included. However, given the significant nature of the extirpative part of the surgery that necessitates reconstruction, it is impossible to compare groups of patients who undergo extensive resection alone against those who undergo different types of reconstruction, as reconstruction is essentially a required part of the comprehensive operative plan to allow the full extirpation needed for definitive treatment.

Additionally, although we recognize that this study may be under powered and too heterogeneous to detect all differences, there was statistical significance of a number of patient and surgical factors on postoperative complication rates, reoperation rates, and hospital LOS. Furthermore, this series is a complete, consecutive case series that illustrates the complex patient and surgical factors involved when caring for this complicated patient population.
CONCLUSIONS

Reconstruction of large pelvic and perineal defects is an important component of treating this very challenging population. In fact, providing wound closure via complex reconstructive capabilities allows for the radical extirpation procedures that are often required to adequately treat these cancers. These data show that the more complicated the defect and its reconstruction, the longer the hospital stay (but not time to complete healing) Increasingly complex reconstruction is not associated with significant differences in complication rates or reoperation. Furthermore, there was no difference among flap types or combination of flap types when comparing time to healing, complication rates, and reoperation rates, suggesting that each are safe and effective when utilized in the appropriate clinical setting. Flap-specific complications and reoperation rates were significantly lower than overall complications and reoperation rate and were not significantly associated with any patient risk factors. Neoadjuvant therapy should not preclude necessary reconstructive procedures, but can shape preoperative risk assessment discussions. These data also show no significantly increased risk of longer LOS or adverse outcomes with increasing age, BMI, or number of comorbidities, indicating that these characteristics should not preclude patients from receiving necessary reconstructive procedures.

Resections of pelvic malignancies are often extensive extirpative operations, which by definition require complex reconstruction; these surgeries generally necessitate a long postoperative course and are associated with relatively high complication and reoperation rates. These data can inform a more evidence-based approach to preoperative counseling and risk assessment, with the ultimate goal of providing a more complete informed consent process for the patient.

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REFERENCES

1. Mirhashemi R, Averette HE, Lambrou N, et al. Vaginal reconstruction at the time of pelvic exenteration: a surgical and psychosocial analysis of techniques. Gynecol Oncol. 2002;87:39–45.
2. Copeland LJ, Hancock KC, Gershenson DM, et al. Gracilis myocutaneous vaginal reconstruction concurrent with total pelvic exenteration. Am J Obstet Gynecol. 1989;160:1095–1101.
3. Carlson JW, Soisson AP, Fowler JM, et al. Rectus abdominis myocutaneous flap for primary vaginal reconstruction. Gynecol Oncol. 1993;51:323–329.
4. Smith HO, Genesen MC, Runowicz CD, et al. The rectus abdominis myocutaneous flap: modifications, complications, and sexual function. Cancer. 1998;83:510–520.
5. Miller B, Morris M, Gershenson DM, et al. Intestinal fistulae formation following pelvic exenteration: a review of the University of Texas M. D. Anderson Cancer Center experience, 1957-1990. Gynecol Oncol. 1995;56:207–210.
6. Soper JT, Secord AA, Havrilesky LJ, et al. Comparison of gracilis and rectus abdominis myocutaneous flap neovaginal reconstruction performed during radical pelvic surgery: flap-specific morbidity. Int J Gynecol Cancer. 2007;17:298–303.
7. Salgarello M, Farallo E, Barone-Adey L, et al. Flap algorithm in vulvar reconstruction after radical, extensive vulvectomy. Ann Plast Surg. 2005;54:184–190.
8. Cordeiro PG, Pusic AL, Disa JJ. A classification system and reconstructive algorithm for acquired vaginal defects. Plast Reconstr Surg. 2002;110:1058–1065.
9. Shridharani SM, Wang HD, Sacks JM. Pedicled anterolateral thigh flap for vaginal and perineal reconstruction. Eplasty. 2013;13:i14.
10. Cheng A, Saint-Cyr M. Split and thinned pedicle deep inferior epigastric perforator (DIEP) flap for vulvar reconstruction. J Reconstr Microsurg. 2013;29:277–282.
11. Benedetti Panici P, Di Donato V, Bracci C, et al. Modified gluteal fold advancement VY flap for vulvar reconstruction after surgery for vulvar malignancies. Gynecol Oncol. 2014;132:125–129.
12. Argenta PA, Lindsay R, Aldridge RB, et al. Vulvar reconstruction using the “lotus petal” fascio-cutaneous flap. Gynecol Oncol. 2013;131:726–729.
13. Bodin F, Weitbruch D, Seigle-Murandi F, et al. Vulvar reconstruction by a “supra-fascial” lottis flap after surgery for malignancies. Gynecol Oncol. 2012;125:610–613.
14. Al-Benna S, Trzakas E. Postablative reconstruction of vulvar defects with local fasciocutaneous flaps and superficial fascial system repair. Arch Gynecol Obstet. 2012;286:445–448.
15. Zeng A, Qiao Q, Zhao R, et al. Anterolateral thigh flap-based reconstruction for oncologic vulvar defects. Plast Reconstr Surg. 2011;127:1939–1945.
16. O’Dey DM, Bozkurt A, Pallua N. The anterior obturator artery perforator (aOAP) flap: surgical anatomy and application of a method for vulvar reconstruction. Gynecol Oncol. 2010;119:526–530.
17. Lazzaro L, Guarneri GF, Rampino Cordaro E, et al. Vulvar reconstruction using a “VY” fascio-cutaneous gluteal flap: a valid reconstructive alternative in post-oncological loss of substance. Arch Gynecol Obstet. 2010;282:521–527.
18. Waghstaff MJ, Rozen WM, Whitaker IS, et al. Perineal and posterior vaginal wall reconstruction with superior and inferior gluteal artery perforator flaps. Microsurgery. 2009;29:626–629.
19. Ozkan O, Akar ME, Ozkan O, et al. The use of vascularized jejunum flap for vaginal reconstruction: clinical experience and results in 22 patients. Microsurgery. 2011;30:125–131.
20. Crosby MA, Hanasono MM, Feng L, et al. Outcomes of partial vaginal reconstruction with pedicled flaps following oncologic resection. Plast Reconstr Surg. 2011;127:663–669.
21. Smeets L, Hendricks B, Teo TC. The propeller flap concept used in vaginal wall reconstruction. J Plast Reconstr Aesthet Surg. 2012;65:620–623.
22. Qiu SS, Jurado M, Hontanilla B. Comparison of TRAM versus DIEP flap in total vaginal reconstruction after pelvic exenteration. Plast Reconstr Surg. 2013;132:1029e–1027e.
23. Berger JL, Westin SN, Fellman B, et al. Modified vertical rectus abdominis myocutaneous flap vaginal reconstruction: an analysis of surgical outcomes. Gynecol Oncol. 2012;125:252–255.
24. Lee PK, Choi MS, Ahn ST, et al. Gluteal fold V-Y advancement flap for vulvar and vaginal reconstruction: a new flap. Plast Reconstr Surg. 2006;118:401–406.
25. Pusic AL, Mehrara BJ. Vaginal reconstruction: an algorithm approach to defect classification and flap reconstruction. J Surg Oncol. 2006;94:515–521.
26. Wu LC, Song DH. The rectus abdominis muscle operational flap for the immediate reconstruction of partial vaginal defects. Plast Reconstr Surg. 2005;115:559–562.
27. Purushothaman V. Horse shoe flap vaginoplasty—a new technique of vaginal reconstruction with labia minora flaps for primary vaginal agenesis. Br J Plast Surg. 2005;58:934–939.
28. Chen HC, Chana JS, Feng GM. A new method for vaginal reconstruction using a pedicled jejunal flap. *Ann Plast Surg*. 2003;51:429–431.

29. Tobin GR, Day TG. Vaginal and pelvic reconstruction with distally based rectus abdominis myocutaneous flaps. *Plast Reconstr Surg*. 1988;81:62–73.

30. Ketjens M, Maggioni A, Bocciolone L, et al. Vaginal reconstruction after extended radical pelvic surgery for cancer: comparison of two techniques. *Plast Reconstr Surg*. 2002;109:1592–1597; discussion 1598.

31. Butler CE, Gündeslioglu AO, Rodriguez-Bigas MA. Outcomes of immediate vertical rectus abdominis myocutaneous flap reconstruction for irradiated abdominoperineal resection defects. *J Am Coll Surg*. 2008;206:694–703.

32. Soper JT, Havrilesky LJ, Secord AA, et al. Rectus abdominis myocutaneous flaps for neovaginal reconstruction after radical pelvic surgery. *Int J Gynecol Cancer*. 2005;15:542–548.

33. D’Souza DN, Pera M, Nelson H, et al. Vaginal reconstruction following resection of primary locally advanced and recurrent colorectal malignancies. *Arch Surg*. 2003;138:1340–1343.

34. Bell SW, Dehni N, Chauvat M, et al. Primary rectus abdominis myocutaneous flap for repair of perineal and vaginal defects after extended abdominoperineal resection. *Br J Surg*. 2005;92:482–486.

35. Ratliff CR, Gershenson DM, Morris M, et al. Sexual adjustment of patients undergoing gracilis myocutaneous flap vaginal reconstruction in conjunction with pelvic exenteration. *Cancer*. 1996;78:2229–2235.

36. Goldberg GL, Sukumvanich P, Einstein MH, et al. Total pelvic exenteration: the Albert Einstein College of Medicine/Montefiore Medical Center Experience (1987 to 2003). *Gynecol Oncol*. 2006;101:261–268.

37. Tei TM, Stolzenburg T, Buntzen S, et al. Use of transpelvic rectus abdominis musculocutaneous flap for anal cancer salvage surgery. *Br J Surg*. 2003;90:575–580.

38. Løve US, Sjøgren P, Rasmussen P, et al. Sexual dysfunction after colpectomy and vaginal reconstruction with a vertical rectus abdominis myocutaneous flap. *Dis Colon Rectum*. 2013;56:186–190.

39. Scott JR, Liu D, Mathes DW. Patient-reported outcomes and sexual function in vaginal reconstruction: a 17-year review, survey, and review of the literature. *Ann Plast Surg*. 2010;64:311–314.

40. Fotopoulou C, Neumann U, Klapp C, et al. Long-term effects of neovaginal reconstruction with sigmoid loop technique on sexual function and self image in patients with gynecologic malignancies: results of a prospective study. *Gynecol Oncol*. 2008;111:400–406.

41. Erman Akar M, Özkan Ö, Özkan Ö, et al. Sexual function and long-term results following vaginal reconstruction with free vascular jejunal flap. *J Sex Med*. 2013;10:2849–2854.

42. Althumairi AA, Canner JK, Gearhart SL, et al. Predictors of perineal wound complications and prolonged time to perineal wound healing after abdominoperineal resection. *World J Surg*. 2016;40:1755–1762.