OPEN

PRS GLOBAL OPEN

SPECIAL TOPIC
Reconstructive

An Algorithmic Approach to Perineal Reconstruction

Catherine M. Westbom, MS
Simon G. Talbot, MD

Summary: Perineal wounds are one of the more challenging plastic surgical defects to reconstruct. Resections in the perineum vary in size and are frequently complicated by radiation, chemotherapy, and contamination. Furthermore, the awkward location and potential need to maintain function of the anus, urethra, and vagina and to allow comfortable sitting all contribute to the complexity of these reconstructions. In light of this complex nature, many options are available for flap coverage. In this paper, we discuss the properties of perineal defects that make each option appropriate. *(Plast Reconstr Surg Glob Open 2019;7:e2572; doi: 10.1097/GOX.0000000000002572; Published online 11 December 2019.)*

INDICATIONS FOR PERINEAL RECONSTRUCTION

Causes of perineal defects (Fig. 1) include different types of malignancies and their treatment, such as colorectal adenocarcinoma, anal squamous cell carcinoma (SCC), vulvar and vaginal SCC, or Paget's disease. Nononcologic causes include trauma, infection (Fournier's gangrene), iatrogenic (radiation damage, urogynecologic implant complications), or congenital.

Perineal reconstruction options range from simple to complex. Often direct closure is possible, but may be inappropriate when the wound is under significant tension, and should only be undertaken judiciously in those with significant risk factors for wound breakdown such as radiated skin, chemotherapy, or active nicotine use. Closure by secondary intent is sometimes appropriate, especially for small or contaminated wounds. This is, however, a difficult location for patients to tolerate packing and—especially for more complex wounds—may be prolonged. Simple techniques including wide undermining, z-plasties, rotation flaps, transposition flaps, and advancement flaps may be appropriate for smaller superficial defects. Larger defects typically require both additional tissue to fill dead space and potentially resurface wounds and may include flaps based on the rectus muscle, gracilis muscle, omentum, or internal pudendal arteries.

In addition to systemic factors that may affect perineal healing, flap choice may be dictated by the availability of donor sites. It is not uncommon for the abdomen to be relatively unavailable. This may be due to the presence of significant hernias, morbid obesity (Fig. 2A), significant weight loss post bariatric surgery, loss of domain (Fig. 2B), abdominal fistulas (Fig. 2C), colostomies (Fig. 2D), urostomies, and the need for future ostomies. Furthermore, use of the rectus muscle is associated with potential morbidity including loss of strength, bulging, mesh-related complications, and hernia formation in between 16% and 26% of patients.[1,2] Mesh use should be considered carefully, especially given the frequent contamination of this operative field, and even more so in inflammatory bowel disease (IBD) patients in whom prosthetic meshes have a higher risk of erosion and fistula formation.[3]

CONTRIBUTORS TO POOR HEALING

The location of the perineum and underlying causes of perineal area resections contribute to poor healing in a multitude of ways.

Contamination

The location of the perineum means that this operative field is frequently *contaminated* with gross stool spillage.

Pressure

Physical *pressure* on the reconstruction is also common during recovery, even when patients are limited in their sitting postoperatively.

Medical Comorbidities

Medical comorbidities are common including obesity, active smoking, and diabetes which can affect wound healing and may be related to the development of various malignancies requiring perineal reconstruction.[4,5]

From the Division of Plastic Surgery, Brigham and Women's Hospital, Boston, Mass.

Received for publication May 2, 2019; accepted October 18, 2019.

DOI: 10.1097/GOX.0000000000002572

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

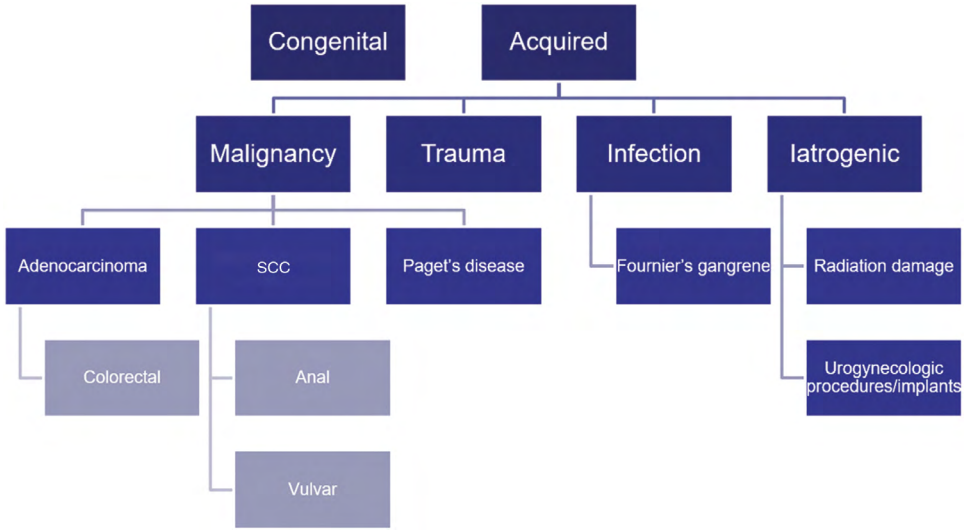

Fig. 1. Causes of perineal defect.

Dead Space

The significant amount of *dead space* post abdominoperineal resection, and *fluid collection* in this space, can predispose patients to infection or wound breakdown.

Defect Size and Field Cancerization

Defect size can become significant for seemingly small lesions due to *field cancerization*, such as when encountering human papillomavirus (HPV)-related cancers including various types of anal, vulvar, or vaginal SCC in which the resection may need to be much larger than the lesion outwardly appears.[6]

Complexity of Structures

Perineal resection can be a palliative option for advanced perineal disease to maintain hygiene and quality of life, necessitating a *larger and more complex* reconstruction than earlier disease stages might require.[7]

Chemotherapy and Immunotherapy

Although oncologic and/or immune-modulating treatments—including *chemotherapy and immunotherapy* for malignancy or *monoclonal antibodies* in IBD—may be necessary, they frequently complicate routine wound healing.[8,9]

Radiation Therapy

Radiation therapy, common in this patient group, may include neoadjuvant radiation for colorectal cancer, prior radiation with treatment intent for anal, vulvar, or vaginal SCC, or unrelated regional radiation such as that given for prostate carcinoma. Radiation directed to the skin for SCC has a more significant effect—likely due to the dose targeted to the superficial tissues—and our experience with brachytherapy suggests an even greater risk of wound complications with this mode of delivery.[10] Radiation has unequivocally been shown to have significant detrimental effect on wound healing.[11]

Prior Surgery

Finally, *prior surgery* causing scarring and/or use of donor sites, such as prior use of the gracilis or internal pudendal artery flaps may limit reconstructive options.

In addition to the abovementioned risk factors complicating reconstruction, these factors may also contribute to the *need* for reconstruction in the first place. More frequent use of neoadjuvant chemoradiation and/or postoperative chemo- or radiation therapies can lead to delayed secondary complications.[12] Examples include fistula disease secondary to prostate cancer radiation or brachytherapy, patients having undergone the NIGRO protocol experiencing wound-healing complications post abdominoperineal resection, monoclonal antibody use, and slowed healing of intrinsic sinuses and fistulae in patients with IBD.[13]

GENERAL RECONSTRUCTIVE PRINCIPLES

Maintain Functionality

When the anus, vagina, or male genitalia requires reconstruction, it is important to consider durability, separation of structures (ie, avoidance of rectovaginal or rectourethral fistulas), and maintenance of sensation if possible.

Achieve a Pain-free Reconstruction

Recovery goals should attempt to achieve a pain-free sitting position. Realistically, however, this may take some months to achieve.

Maintenance of Continence

When the anus or urethra is maintained, a "sufficient level" of continence must be achievable. Conversely, an overly scarred anus or urethral orifice can produce complications including difficult stool passage or urinary spraying and should be avoided whenever possible. When these goals are not possible, greater consideration should be given to the options of a colostomy and/or urostomy.

Fig. 2. An abdominal donor site may be unavailable. A, Patient with morbid obesity and significant abdominal pannus with a large hernia. B, Loss of domain in a previously open abdomen previously treated with a skin graft. C, Fistula disease of the central abdomen with a history of omphalocele. D, Patient with vertical and transverse abdominal scarring, right-sided hernia, Crohn's disease, and a colostomy on the left.

Choose Minimally Complicated Donor Sites in Consideration of the Whole Surgical Plan

Donor sites should be chosen considering the likelihood and severity of complications at the *donor site* (and the *recipient site*), and past and possible future surgical needs in mind. For example, patients undergoing abdominoperineal resections require an optimal site for an ostomy and may require future resiting. Those undergoing pelvic exenteration will require both a colostomy and urostomy, usually on each side of the abdomen. Avoiding harvest of the rectus (when appropriate) leaves more options for ostomy placement and revision if needed.

Maximize Predictable Results

When deciding on flap choice, consider the predictability of the result, and when appropriate, opt for the most reliable and predictable option.

Maintain Esthetics if Possible

Achieving an esthetically acceptable result should not be overlooked. This can often be both safe and complementary to the functional outcome of the reconstruction.

RECONSTRUCTIVE ALGORITHM

Categorizing perineal defects is useful to determine the best reconstructive option.[14,15] We divide perineal wounds into 2 groups: simple and complex.

Simple Defect Algorithm

For those defects that are both superficial and small, it is sometimes possible to close directly or close by secondary intent. The latter option is particularly relevant if this is immediately adjacent to the anus and/or will be heavily contaminated. For superficial defects that are small, but cannot be closed directly, various local flap options include local flaps using the labia, VY flaps from the buttock, and/or keystone flaps(Fig. 3).

Complex Defect Algorithm

When a defect involves more than just skin resection, or the patient presents with significant risk factors for complications (as listed earlier), we use an algorithm based on the nature and size of the defect, tissues required, and structures requiring reconstruction (Fig. 4). Numerous studies have shown the benefits of flap closure for larger

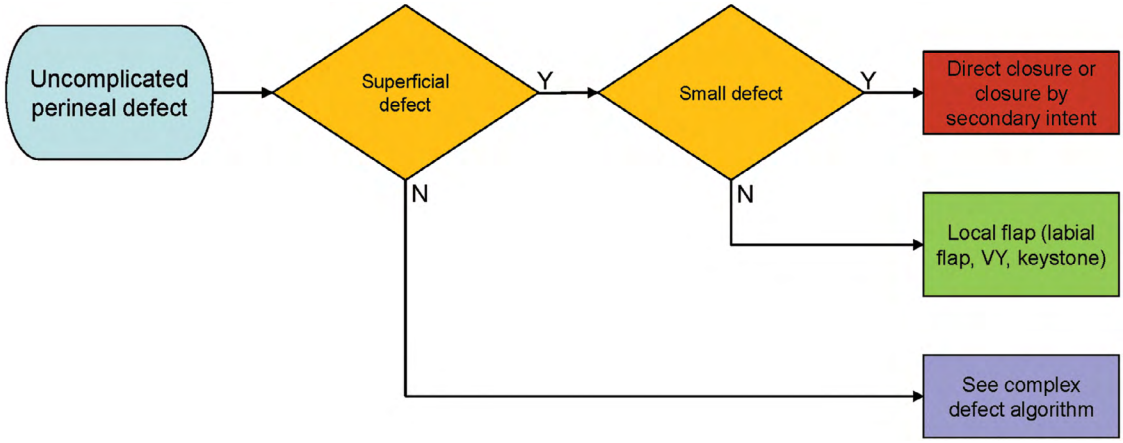

Fig. 3. Simple defect algorithm.

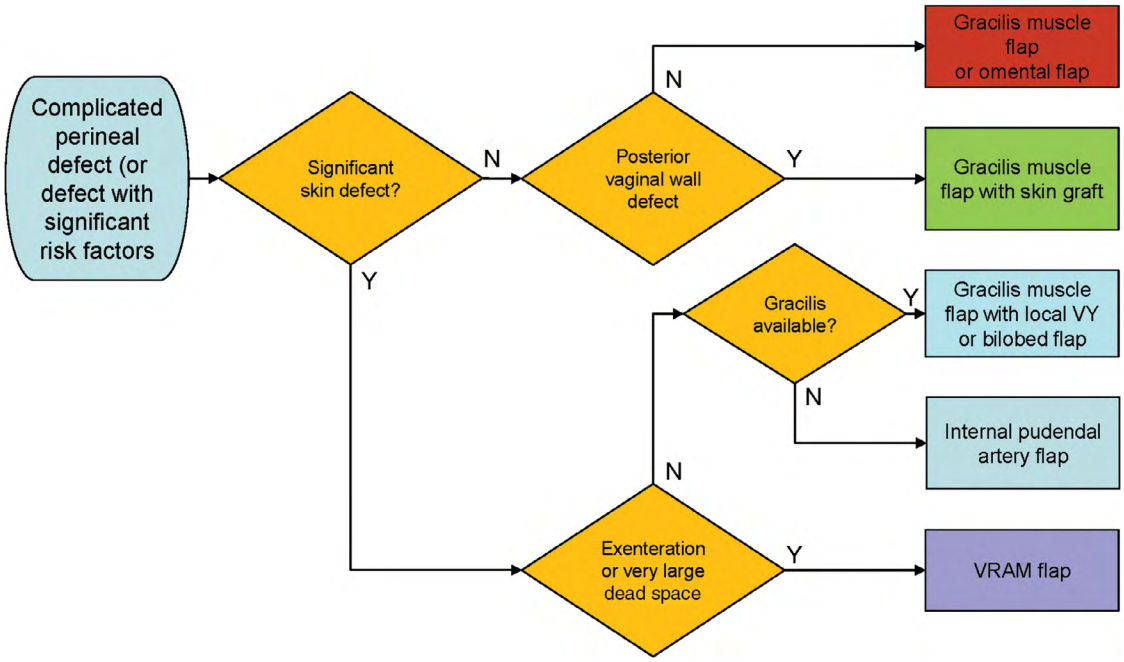

Fig. 4. Complex defect algorithm.

perineal defects including a greater than 50% reduction in complications versus direct closure for oncologic defects,[16] and a reduction in total and major perineal wound complications specifically following abdominoperineal resection.[17]

Small Defect, without Posterior Vaginal Wall Resection

In small defects involving prior radiation or in the setting of fistulas, we typically use a gracilis muscle-only flap, an omental flap, or both to fill dead space with nonradiated tissue and/or bolster the repair of a fistula tract.[18] Both the gracilis and omental flap options are relatively rapid and easy to harvest.

Of note, the gracilis muscle can be particularly small in cachectic, paraplegic, or nonambulatory patients, and another flap may be preferable in this group.

The *gracilis muscle-only flap* is relatively rapid and easy to perform with minimal donor site morbidity.[4,19] This flap can be performed open or through a limited incision approach—with distal and proximal thigh incisions using a lighted retractor. The epimysium is left in place and the muscle dissected to the tendinous distal portion to allow tacking of the distal end of the muscle/tendon to the sacrum. We avoid joining the perineal and thigh incisions to prevent future healing problems and contractures (Fig. 5). As convenient as resorbable sutures can be, we usually use nylon sutures in the skin of the perineum to ensure that sutures remain in place until incisions are fully healed and to prevent the cutaneous reaction that absorbable sutures often cause. Drains are left both in the thigh and perineum for an extended period (until almost dry) to prevent fluid collection and seroma formation in this easily

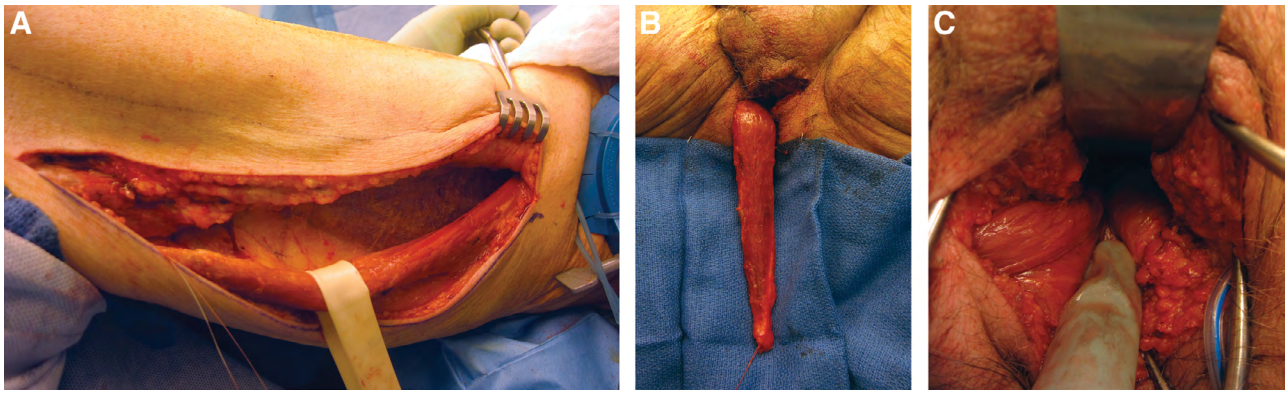

Fig. 5. Gracilis muscle flap. A, Open incision approach to gracilis muscle-only flap harvest, avoiding the connection of thigh and perineum incisions. B, With careful pedicle dissection, a significant length of muscle can be tunneled to the perineum. C, Gracilis muscle inset.

contaminated area. This operation has moderate recipient site complications, varying from minor dehiscence to minor infections that are typically managed conservatively. As a result, we rarely use a bilateral gracilis flap, preferring to conserve the second to manage any unpredictable area of wound complication that is not apparent until after the initial surgery. Rare donor site complications are seen, such as seromas and infections. In terms of donor site complications, we have found the gracilis flap to be preferable when compared to the vertical rectus abdominis myocutaneous (VRAM) flap, similar to numerous additional authors.[4,19–24]

The *omental flap* is excellent at closing a large amount of dead space and is relatively straightforward to harvest, especially during concurrent abdominal surgery (Fig. 6). We typically avoid this flap unless the abdomen is already open for a concurrent bowel procedure. This flap has minimal donor site morbidity and reliable vascularity.[25] However, due to previous surgeries in the area, the omentum can be unavailable in this patient population, additionally it cannot aid in the reconstruction of skin defects. We typically mobilize the omentum after the abdominal resection is complete using the LigaSure (Medtronic, MN), but ensure that we discuss this with the general surgery team to ensure that the omentum is kept intact. We use the larger right gastroepiploic pedicle when sufficient length is available. Of note, when dissecting the omentum, adequate dissection is necessary to avoid tension on the pedicle and the resulting creation of a tight "band" of the pedicle across the abdominal viscera, which may contribute to an internal hernia, and if this is the case and when only a short omentum is available we sometimes use the left gastroepiploic to prevent the pedicle having to cross the abdomen.

When the omental flap or gracilis muscle-only flap cannot fill the dead space alone, both together may fill the dead space adequately.

Fig. 6. Omental flap to fill abdominoperineal dead space.

Small Defect, with Posterior Vaginal Wall Resection

Where the posterior vaginal wall has been resected, we use a *gracilis flap to fill the dead space with additional full-thickness skin graft* directly onto the muscle to reconstruct the posterior vaginal wall. This is preferable to direct closure of the posterior vaginal wall, which can cause secondary functional complications resulting from tension or too small a diameter. We harvest the small full-thickness skin graft from the same incision in the thigh used for the gracilis flap to avoid the need for a second donor site. Over several months, the skin graft will mucosalize, forming a functional substitute to the vaginal wall (Fig. 7). Benefits to this technique when compared to use of the myocutaneous gracilis flap include avoiding the unreliable myocutaneous gracilis skin paddle (which is particularly unreliable in obese patients with long perforators that can easily kink or twist). Additionally, by using this technique, we minimize the complications that arise with abdominal-based flaps.[4,26]

Significant Skin Defect with Relatively Small Dead Space

When the skin defect is significant, but dead space is moderate to small, such as after resecting Paget's disease, we consider using a VY flap from the buttock or thigh or bilobed flap from the thigh to cover the skin defect. We

Fig. 7. A small skin graft is seen replacing the lost tissue of the posterior vaginal wall.

typically use a thigh-based flap for more anterior defects and a buttock-based flap for more posterior defects; bilobed flaps help to close a donor site under minimal tension when there is limited tissue available. The gracilis flap can be added if needed for managing dead space in the deeper aspects. In addition, internal pudendal artery flap or myocutaneous gracilis flap may be used in select patients, usually those with a low body mass index, thus reducing the chance of flap venous congestion.

For larger superficial defects, most commonly for gynecological indications, simple *thigh VY advancement* flaps can be used for closure. There are many benefits to making these flaps large, such as to ensure the presence of reliable perforators within the flap (especially to the most advancing skin edge), to ensure enough tissue to cover the defect, and to allow for possible readvancement in the event of recurrent disease and reresection. This is a good option in the setting of an exenteration, in which both a colostomy and urostomy will be needed on opposing sides of the abdomen, thus leaving the abdominal wall untouched for placement of these stomas (Fig. 8).

If there is a need for muscle to fill a deeper dead space, the combination of *gluteal VY flaps with a gracilis flap* can be used. Similar to the thigh-based VY flaps, these must also be large flaps even when the area to be reconstructed seems small (Fig. 9). In the gluteal region, for best mobilization of the flap to ensure minimum tension, it is beneficial to divide both the superficial fascia and the deep muscle fascia which is the site of maximal tethering. We also often thin the deeper layer of fat from the flap to allow ease of inset on the anal margin. Through these techniques, one can avoid the placement of tension onto the anal mucosa which often results in leakage, soiling, and discomfort due to exposure of anal mucosa. In practice, it is best to perform this with the patient prone or in the jackknife position with preplaced anal margin sutures.

By using a *bilobed flap*, one can harvest a very large skin paddle from the proximal thigh perforators using a longitudinal skin paddle to close this transverse donor site. Separately, the gracilis can be easily harvested as a muscle flap to fill dead space underneath.

For relatively small perineal defects of the cutaneous or soft tissue where the gracilis is unavailable, we consider use of the *internal pudendal artery flap*, often based on a perforator vessel. Concerns with this technique involve a donor site in the gluteal crease leading to healing complications and the anatomically difficult donor site from which to harvest. The patient shown in Figure 10A had

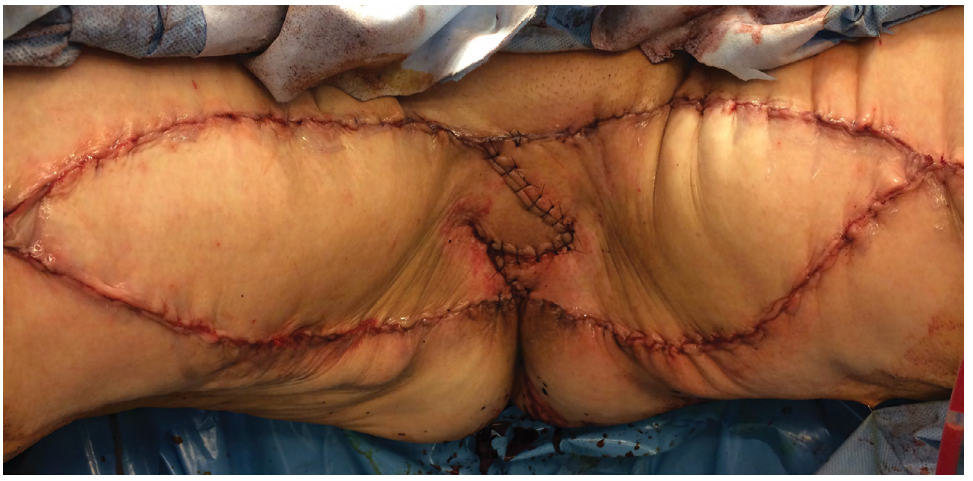

Fig. 8. Bilateral thigh VY advancement flap with interposed ends.

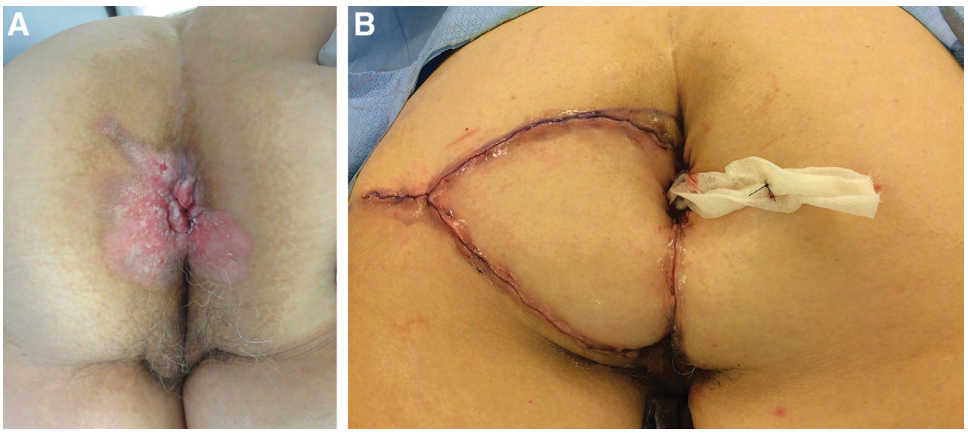

Fig. 9. Gluteal VY flap. A, Apparently small area surrounding the anus to be reconstructed in a patient with Paget's disease. B, Large gluteal VY flap with minimal tension and option for possible later advancement if necessary.

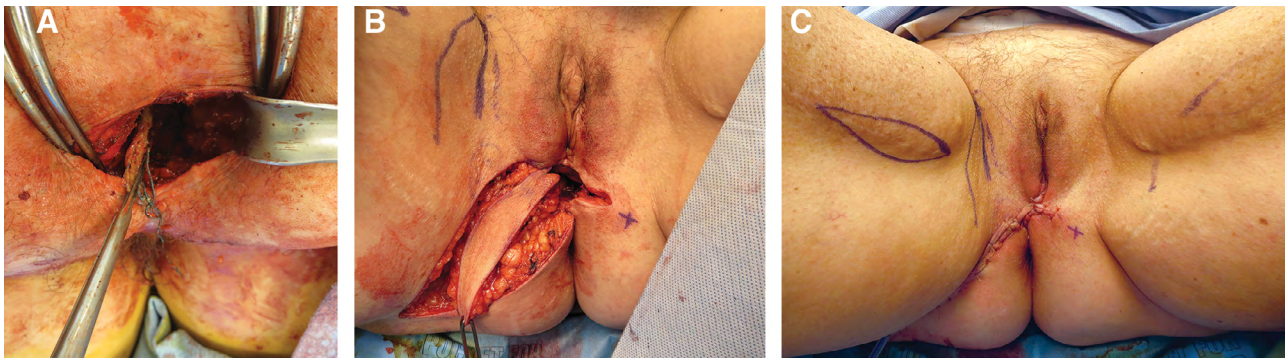

Fig. 10. Internal pudendal artery flap. A, Mesh removal and defect caused by rectovaginal fistula. B, Internal pudendal artery perforator flap. C, Inset of internal pudendal artery flap in a patient without availability of the gracilis muscles.

complications including a fistula from a prior mesh sling: 2 previous gracilis flaps having been used in an attempt to repair the defect before sling removal. The internal pudendal artery flap was de-epithelialized and used to repair a rectovaginal fistula, followed by primary closure (Fig. 10B and C).

The *myocutaneous gracilis flap* can be useful for closure of dead space with additional need for skin, but careful patient selection is critical. Capturing adequate perforators and protecting them from kinking or twisting can be difficult in obese patients with long distances between cutaneous perforators and vessels of origin. We try to avoid this complication by performing this flap only in patients with thin thighs and those who have not undergone significant weight changes. To best ensure success, a Doppler is used to locate a perforator when selecting the skin paddle and dissection started anteriorly to encircle the gracilis from above and deep before defining the posterior aspect of the skin paddle. This way, we ensure a perforator remains in the flap before defining the limits to the skin paddle. The flap is inset loosely to prevent excessive tension, pressure, or kinking of perforators. This patient underwent myocutaneous gracilis flap post advanced perineal malignancy (Fig. 11).

Significant Skin Defect with Large Dead Space

In patients with large skin defects and a large dead space (such as after pelvic exenteration), we prefer the use of the VRAM flap.[26,27] We are, however, judicious in using abdominal-based flaps due to the increased abdominal wall morbidity which may offset the benefit in the perineum.[4] The VRAM flap can be tunneled through the pelvis, something that is convenient during concurrent abdominal surgery. Tunneling of the flap reduces the distance that the pedicle must travel, but logistically requires careful planning on the part of the resecting and reconstructive surgeons. Ideally, the flap is harvested while the patient lies supine, and the perineal part of the resection and inset is done with the patient prone, requiring clear communication between resecting and reconstructing surgeons to estimate defect and flap sizes. Care must be taken that the pedicle is not kinked or twisted, especially when passing it through the pelvis after turning the patient from supine to prone. When designing the flap, effort should be made to maximize the cutaneous paddle, particularly capturing periumbilical perforators. This can be easily achieved through a long vertical skin paddle (potentially using an oblique extension beneath the costal margin), but de-epithelializing the part of the paddle that cannot reach the perineal defect. This way a dermal plexus is maintained

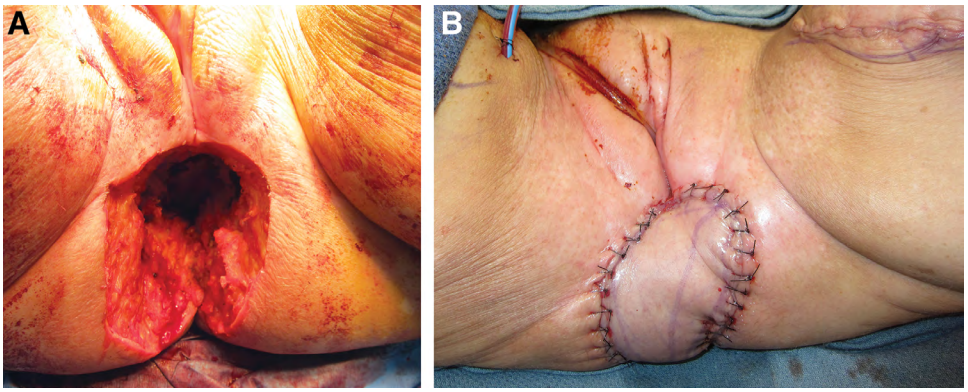

Fig. 11. Myocutaneous gracilis flap. A, Defect requiring both muscular and skin components for closure, B, Myocutaneous gracilis flap.

from the reliable periumbilical perforators to the necessary skin paddle distally. Tissue attached to the muscle flap can prevent venous congestion, as shown in this case. The VRAM flap can successfully be used to fill dead space in the perineum extending to the top of the coccyx.

This flap may also be useful when concurrently reconstructing advanced malignancy in the inguinal region requiring lymph node dissection. The high frequency of lymphedema may be reduced by passing this flap external to the pelvis and leaving a skin bridge to aid in lymphedema drainage through the dermis.

CONCLUSIONS

Perineal reconstruction requires a multifaceted approach to surgical planning. We believe that an algorithmic approach based on the defect and requirements of the reconstruction is helpful in deciding on the optimal operation. In determining what is best for the care of the individual patient, interdisciplinary communication is of upmost importance. Complication rates with these defects and their reconstruction are high. This is especially true in patients who are obese, smoke, and/or are going through or have undergone chemoradiation. However, with careful planning and execution, it is possible to obtain a functional, pain-free, and predictable result.

Simon G. Talbot, MD
Associate Professor of Surgery
Harvard Medical School
Division of Plastic Surgery
Department of Surgery
Brigham and Women's Hospital
75 Francis Street
Boston, MA 02115
Email: sgtalbot@bwh.harvard.edu

REFERENCES

1. Sunesen KG, Buntzen S, Tei T, et al. Perineal healing and survival after anal cancer salvage surgery: 10-year experience with primary perineal reconstruction using the vertical rectus abdominis myocutaneous (VRAM) flap. *Ann Surg Oncol.* 2009;16:68–77.
2. Küntscher MV, Mansouri S, Noack N, et al. Versatility of vertical rectus abdominis musculocutaneous flaps. *Microsurgery.* 2006;26:363–369.
3. Feiner B, Jelovsek JE, Maher C. Efficacy and safety of transvaginal mesh kits in the treatment of prolapse of the vaginal apex: a systematic review. *Bjog.* 2009;116:15–24.
4. Singh M, Kinsley S, Huang A, et al. Gracilis flap reconstruction of the perineum: an outcomes analysis. *J Am Coll Surg.* 2016;223:602–610.
5. Christian CK, Kwaan MR, Betensky RA, et al. Risk factors for perineal wound complications following abdominoperineal resection. *Dis Colon Rectum.* 2005;48:43–48.
6. Torezan LA, Festa-Neto C. Cutaneous field cancerization: clinical, histopathological and therapeutic aspects. *An Bras Dermatol.* 2013;88:775–786.
7. Hope JM, Pothuri B. The role of palliative surgery in gynecologic cancer cases. *Oncologist.* 2013;18:73–79.
8. Yang Z, Wu Q, Wang F, et al. Meta-analysis: effect of preoperative infliximab use on early postoperative complications in patients with ulcerative colitis undergoing abdominal surgery. *Aliment Pharmacol Ther.* 2012;36:922–928.
9. Mor IJ, Vogel JD, da Luz Moreira A, et al. Infliximab in ulcerative colitis is associated with an increased risk of postoperative complications after restorative proctocolectomy. *Dis Colon Rectum.* 2008;51:1202–7; discussion 1207.
10. Matalon SA, Mamon HJ, Fuchs CS, et al. Anorectal cancer: critical anatomic and staging distinctions that affect use of radiation therapy. *Radiographics.* 2015;35:2090–2107.
11. Rudolph R, Arganese T, Woodward M. The ultrastructure and etiology of chronic radiotherapy damage in human skin. *Ann Plast Surg.* 1982;9:282–292.
12. Bullard KM, Trudel JL, Baxter NN, et al. Primary perineal wound closure after preoperative radiotherapy and abdominoperineal resection has a high incidence of wound failure. *Dis Colon Rectum.* 2005;48:438–443.
13. Shah B, Mayer L. Current status of monoclonal antibody therapy for the treatment of inflammatory bowel disease. *Expert Rev Clin Immunol.* 2010;6:607–620.
14. John HE, Jessop ZM, Di Candia M, et al. An algorithmic approach to perineal reconstruction after cancer resection–experience from two international centers. *Ann Plast Surg.* 2013;71:96–102.
15. Mericli AF, Martin JP, Campbell CA. An algorithmic anatomical subunit approach to pelvic wound reconstruction. *Plast Reconstr Surg.* 2016;137:1004–1017.
16. Devulapalli C, Jia Wei AT, DiBiagio JR, et al. Primary versus flap closure of perineal defects following oncologic resection: a systematic review and meta-analysis. *Plast Reconstr Surg.* 2016;137:1602–1613.

17. Yang XY, Wei MT, Yang XT, et al. Primary vs myocutaneous flap closure of perineal defects following abdominoperineal resection for colorectal disease: a systematic review and meta-analysis. *Colorectal Dis*. 2019;21:138–155.
18. Hotouras A, Ribas Y, Zakeri S, et al. Gracilis muscle interposition for rectovaginal and anovaginal fistula repair: a systematic literature review. *Colorectal Dis*. 2015;17:104–110.
19. Wexner SD, Ruiz DE, Genua J, et al. Gracilis muscle interposition for the treatment of rectourethral, rectovaginal, and pouch-vaginal fistulas: results in 53 patients. *Ann Surg*. 2008;248:39–43.
20. Chong TW, Balch GC, Kehoe SM, et al. Reconstruction of large perineal and pelvic wounds using gracilis muscle flaps. *Ann Surg Oncol*. 2015;22:3738–3744.
21. Takano S, Boutros M, Wexner SD. Gracilis muscle transposition for complex perineal fistulas and sinuses: a systematic literature review of surgical outcomes. *J Am Coll Surg*. 2014;219:313–323.
22. Chan S, Miller M, Ng R, et al. Use of myocutaneous flaps for perineal closure following abdominoperineal excision of the rectum for adenocarcinoma. *Colorectal Dis*. 2010;12:555–560.
23. Persichetti P, Cogliandro A, Marangi GF, et al. Pelvic and perineal reconstruction following abdominoperineal resection: the role of gracilis flap. *Ann Plast Surg*. 2007;59:168–172.
24. Shibata D, Hyland W, Busse P, et al. Immediate reconstruction of the perineal wound with gracilis muscle flaps following abdominoperineal resection and intraoperative radiation therapy for recurrent carcinoma of the rectum. *Ann Surg Oncol*. 1999;6:33–37.
25. Hultman CS, Carlson GW, Losken A, et al. Utility of the omentum in the reconstruction of complex extraperitoneal wounds and defects: donor-site complications in 135 patients from 1975 to 2000. *Ann Surg*. 2002;235:782–795.
26. Nelson RA, Butler CE. Surgical outcomes of VRAM versus thigh flaps for immediate reconstruction of pelvic and perineal cancer resection defects. *Plast Reconstr Surg*. 2009;123:175–183.
27. Johnstone MS. Vertical rectus abdominis myocutaneous versus alternative flaps for perineal repair after abdominoperineal excision of the rectum in the era of laparoscopic surgery. *Ann Plast Surg*. 2017;79:101–106.