Soft Tissue Reconstruction Following Sacrectomy

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Primary sacral tumors are uncommon and fortunately the majority are low-grade malignancies; however, without negative surgical margins, these tumors have a high predilection for local recurrence [1]. Thus, the goal of surgery is complete tumor extirpation. In order to obtain a negative margin, large soft tissue defects are created. Unfortunately, these large resections are prone to infection and complications. The utilization of immediate soft tissue reconstruction with myocutaneous flaps has allowed the surgeon to bring well-vascularized tissue into the resection area, obliterate dead space, and preserve abdominal domain.

Local soft tissue flap reconstruction of these defects can be compromised by immobile radiated tissues and lack of local posterior soft tissue due to its removal with the tumor specimen. Historically, these wounds were left to close by secondary intention and often resulted in extensive scarring, as well as an unstable soft tissue envelope which leads to a prolonged hospital course due to the associated complications. Over the past 2 decades, myocutaneous flap reconstruction of these defects has lowered morbidity and also allowed for more aggressive surgical resection of the primary tumor. Over the past decade, we have found that there are two flaps that provide reliable soft tissue coverage for these complex defects. The purpose of this chapter is to provide an overview of the common indications and techniques for soft tissue reconstruction following sacrectomy and to review our reconstructive algorithm.

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24.1 Flap Planning

It is important to have a multidisciplinary team approach from the start of the case in order to mark out any colostomy or ileostomy sites to facilitate flap design. This is important because an inappropriately placed colostomy or ileostomy could potentially compromise abdominal flap elevation. In addition, prior to surgery, we advocate for the placement of ureteral stents that assist with identification of the ureters during tumor extirpation. Patient positioning for the case is dependent on the location of the tumor, if the tumor involves S2 or higher our preference is for a two-stage resection beginning with the patient supine for an anterior abdominal exploration followed by a posterior resection, which is performed with the patient in the prone position. Tumors which are located at S3 or lower may be removed through a pure posterior approach thus allowing the patient to be positioned prone on the operating room table. Prior to the start of the procedure, the plastic surgery team will mark the area for flap dissection based on the type of defect.

24.2 Sacral Reconstruction

Sacral resections have historically been associated with high postoperative morbidity due to the complex local anatomy and poor wound healing potential of these wounds. As previously mentioned, at our institution, distal sacral resections are typically performed through a posterior approach, while larger tumors, those spreading from the viscera (colon cancer) and cephalad to S3, require a combined anterior and posterior resection. Soft tissue reconstruction of these defects is either preformed with omental flaps, V–Y advancement flaps, or vertical rectus abdominis musculocutaneous (VRAM) depending on wound dimensions. These flaps obliterate the potential space left following tumor extirpation and allow for a tension-free closure of the wound. Depending on the size of the soft tissue defect, these flaps can be used in isolation or combined.

24.2.1 Omental Pedicled Flap

The omentum is easily accessible during the laparotomy used for exposure during the anterior approach. Since omentum can be scarred and adherent to abdominal organs, a previous history of abdominal surgery or abdominal infection may preclude the use of this flap.

The omentum flap may be based on either the right or left gastroepiploic artery. If the flap is based on the right gastroepiploic vessels, the short gastric vessels can be divided along the greater curvature of the stomach, allowing for mobilization of the omentum. The omentum can then be tucked into the residual soft tissue defect to obliterate the potential space left from tumor extirpation. While the flap is very good for obliterating dead space, it has little structural strength; thus, it is not an ideal flap when a significant portion of the abdominal wall or buttock area has been

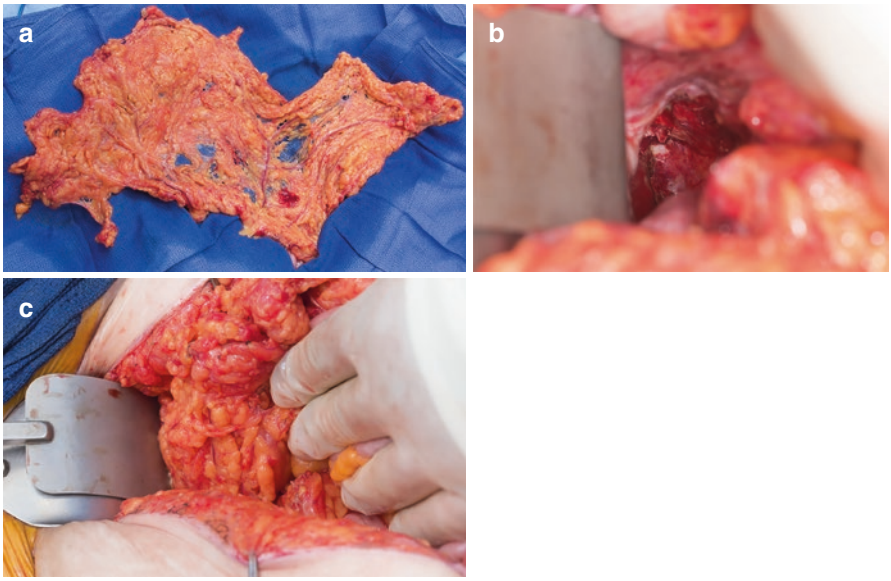

Fig. 24.1 During an anterior exposure, the omentum is easily accessible and significant mobilization can be acheived through the anterior laporotomy incision (**a**). Following removal of a tumor, there is often a large potential space (**b**). The omentum can be mobilized and "tucked" into this space obliterating the dead space (**c**)

excised. We prefer to use this flap for low-grade tumors where skin closure is not an issue. In these cases, the omentum can be tucked into the area of tumor extirpation and help to prevent the development of postoperative seroma and infection. Since the flap requires manipulation of the viscera, we recommend a gradual resumption of feeding until the bowel and stomach function return to baseline (Fig. 24.1).

24.2.2 V–Y Advancement Gluteal Flaps

The V–Y advancement flaps are performed as a composite flap (fasciocutaneous and myocutaneous). Due to the loss of gluteal strength following the procedure, the flap is safer from a functional standpoint to perform in paraplegic patients but can also be used in ambulatory patients if the flap is modified to not include the muscle. The flap is based on the superior and inferior gluteal vessels. The use of this flap is contraindicated if there is concern about the patency of the gluteal vessels (and this may be the cases if there has been substantial preoperative gluteal radiation or preoperative embolization of the internal iliac vessels). In most cases, the donor site may be closed primarily, but in cases of very large flaps, the donor site can be skin grafted or left to heal by secondary intention. We prefer to use this flap (Fig. 24.2) only for patients undergoing an entirely prone procedure (caudal to S3). The tissue available with this flap is limited, and it is often not possible to obliterate larger deep pelvic spaces with this flap.

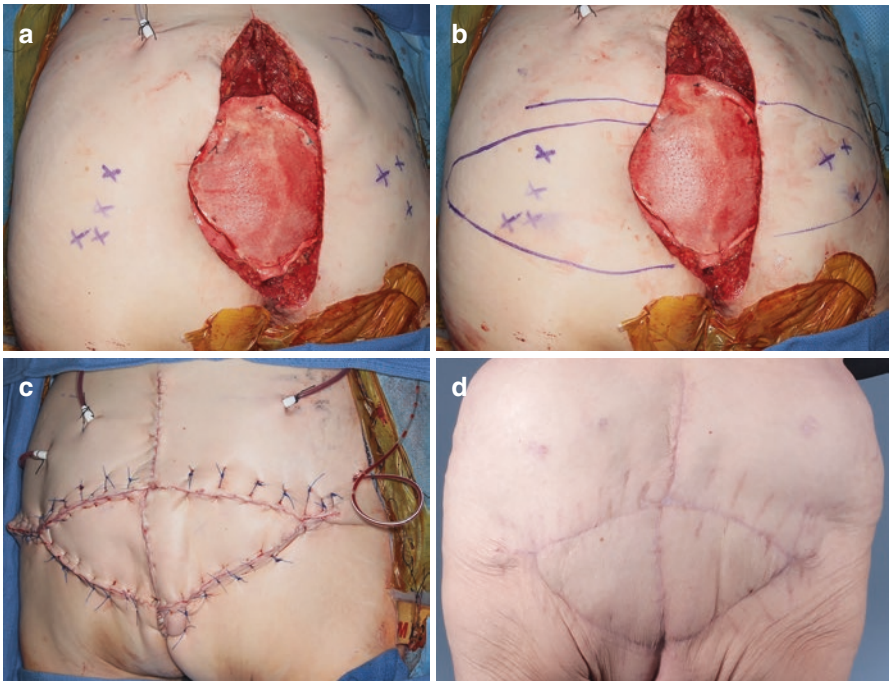

Fig. 24.2 For coverage of posterior-only sacrectomies, a V–Y advancement flap can be planned based on perforators from the gluteal vessels (**a**). Incisions are planned based on the location of the perforators (**b**), and the flaps can be elevated as either a fasciocutaneous or myocutaneous flap. The flaps are then mobilized to the midline (**c**). At 8-month postoperative, the flap has reliably healed (**d**)

24.2.3 Rectus Abdominis Musculocutaneous Flap

The rectus abdominis muscle can be elevated alone or as a composite flap with a skin paddle. The skin paddle can be elevated as a transverse rectus abdominis musculocutaneous (TRAM) or as a vertical rectus abdominis musculocutaneous (VRAM) flap, which can be either a distally based pedicle flap (inferior epigastric vessels) or microvascular free flap. We most commonly use a VRAM based on the deep inferior epigastric artery (DIEA). The DIEA arises above the inguinal ligament and lies superior to the peritoneum, but deep to the transversalis fascia. Once the pedicle enters the rectus sheath, it divides into the medial and lateral branches and located lateral to the muscle. The flap is elevated off the abdominal wall with both these perforators, with care taken to leave the flap attached the pubic ramus to prevent kinking of the pedicle.

The VRAM is the workhorse for reconstruction and can be used for a majority of soft tissue defects following sacrectomy. If there is a large skin defect, then we preferred to use a pedicled TRAM flap. Since these flaps are based on the inferior epigastric vessels, a detailed history of previous intra-abdominal surgery should be obtained in order to determine if the DIEA may have been previously divided (open appendectomy, inguinal hernia, colostomy, cesarean section, etc.). If there is a concern that the pedicle has been damaged, a duplex ultrasound or CTA should be performed to confirm patency.

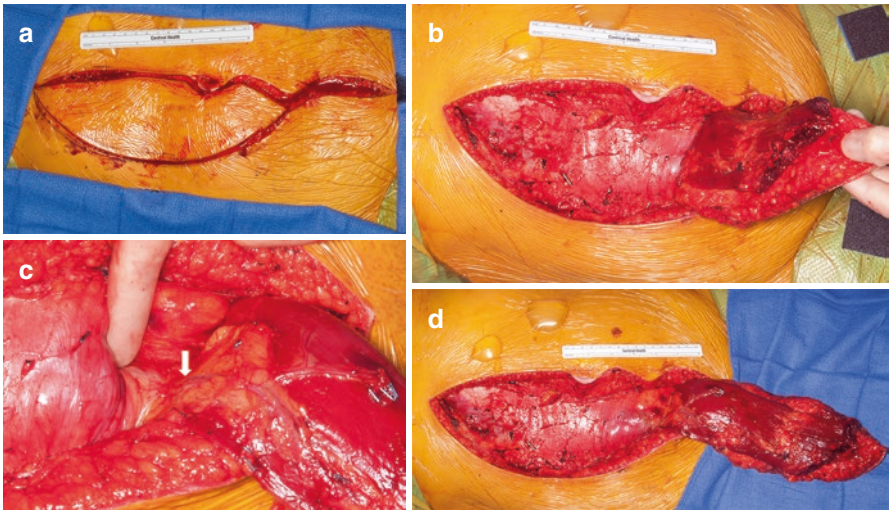

Fig. 24.3 The vertical rectus abdominis musculocutaneous (VRAM) flap is planned prior to the anterior exposure of the tumor (**a**) and is measured based on the anticipated amount of posterior skin resection. The rectus is elevated off the abdominal wall (**b**) with care taken not to kink the perforators of the deep inferior epigastric artery (**c**—*arrow*). Once mobilized (**d**), the anterior exposure of the tumor is undertaken and the flap is tucked into the abdomen

The VRAM flap should be elevated prior to abdominal exploration. A large skin paddle should be planned in order to close the posterior soft tissue defect (Fig. 24.3). The rectus sheath is opened near the midline and elevated off the rectus abdominis muscle in the areas that are away from the skin island. Care should be taken to avoid the pedicle which lies on the undersurface of the muscle. The flap is left attached to the pubis and a stich is placed to mark superior orientation of the skin paddle. The flap is placed in a plastic bag or wrapped in a laparotomy pad and placed over the anterior portion of the lumbar spine and sacrum for easy identification during the posterior approach. The flap is then left buried in the abdomen until the posterior portion of the procedure is performed.

If there is a large anterior fascial defect following flap harvest, the fascia can be reconstructed using a synthetic mesh or acellular dermal matrix. The repair of these defects should be tension-free preferably with an absorbable mesh such as Vicryl® (Ethicon Inc., Cincinnati, Ohio, USA) or a biologic mesh such as AlloDerm® (Lifecell Corporation, Branchburg, NJ, USA) or Surgisis® (Cook Surgical, Bloomington, IN, USA). Although both options are viable, the use of a biologic mesh is costly and patients can sustain an abdominal wall hernia or bulge in long-term follow-up.

During the posterior portion of the procedure, the VRAM flap is easily identified following resection of the sacrum (Fig. 24.4). Similar to the anterior reconstruction, a biologic mesh (AlloDerm®) is used to reconstruct the posterior abdominal wall. The pelvis and spine are stabilized, and the biologic mesh is then anchored to the pelvis deep to the surgical hardware to prevent herniation of the viscera. A small opening is left in the inferior portion of the mesh to allow for the pedicle of the VRAM flap to be passed through the defect. Following the reconstruction, the flap

Fig. 24.4 Following a combined anterior and posterior approach to the sacrum, reconstructive surgeons are often faced with large posterior soft tissue defects (**a**). A biologic mesh is used to reconstruct the posterior abdominal wall, and the vertical rectus abdominis musculocutaneous (VRAM) is pulled through a small opening in the mesh (**b**). The flap is then inset into the posterior defect without tension (**c**). In this patient, the flap reliably healed (**d**)

should be inset without tension or kinking of the pedicle in order to prevent wound breakdown when the patients start to sit.

24.3 Postoperative Management

Patients are monitored in the ICU for at least the first postoperative night. Adequate fluid resuscitation improves flap perfusion; thus, blood pressure should be supported with fluids or blood products rather than vasopressors. We recommend for the use of a Clinitron® bed (Hill-Rom, Chicago, IL, USA) to avoid pressure injury to the flap, as many patients will be insensate over the ischial and sacral region. Physical and occupational therapy services are involved early, and when it is safe from surgical prospective, patients can begin ambulating and sitting.

Depending on the size of the defect, one or multiple drains can be placed to prevent hematoma or seroma formation. Large fluid accumulations can compromise the soft tissue reconstructions through direct pressure on the vascular pedicle or by the development of deep infection. In accordance with oncologic principles, the drains should exit the skin in line with and close to an incision in case it has to be resected at later date for tumor recurrence. Typically, drains are kept in place until the output decreases to less than 30 cc per day, but often are left in place longer in large or irradiated wound beds.

24.4 Complications

Wound complications are the most common postoperative complications following sacrectomy. In a series from our institution, authored by Maricevich and colleagues, we noted a 40% complication rate, with a majority of the complications related to skin dehiscence [2], even with the postoperative use of a Clinitron® bed. Since wound complications prevent adjuvant therapy (such as chemotherapy), uncomplicated wound healing is essential for optimum care and highlights the need for a multidisciplinary team including plastic surgeons to optimize wound healing. The high rate of complications following these complicated surgeries has been corroborated in other large series of partial and total sacrectomies [3, 4]. Despite a high rate of wound and abdominal complications, Maricevich and colleagues reported no flap loss following these procedures [2]. Wound complications were found to be associated with the surgical approach; patients reconstructed with a V–Y flap were at greatest risk of complications [2]. This is most likely due to the fact that the V–Y advancement flap lacks the bulk necessary to obliterate deeper spaces, elevating the risk for fluid accumulation. The study found that the use of acellular dermal matrix to reconstruct the posterior abdominal significantly reduces the risk of posterior bowel herniation and reduces the incidence of bowel obstruction and fistula formation [2].

Currently, at our institution, we use gluteal flaps for smaller defects following isolated posterior procedures. Even in the setting of smaller wound defects, any time there is a combined anterior and posterior approach, we advocate for the use of a VRAM flap. Although reconstruction is technically difficult following a sacrectomy, the use of the VRAM and biological matrix to reconstruct the posterior abdominal wall is our preferred technique to provide patients with the best outcomes.

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