Considerations in Abdominal Wall Reconstruction

Justin M. Sacks, M.D.¹ Justin M. Broyles, M.D.¹ Donald P. Baumann, M.D., F.A.C.S.²

¹Department of Plastic and Reconstructive Surgery, The Johns Hopkins Hospital, Baltimore, Maryland

²Department of Plastic Surgery, The University of Texas M.D. Anderson Cancer Center, Houston, Texas

Address for correspondence and reprint requests Justin M. Sacks, M.D., Johns Hopkins Outpatient Center, 601 N. Calvert St., Suite 8140D, Baltimore, MD 21287 (e-mail: jmsacks@jhmi.edu).

Semin Plast Surg 2012;26:5–7.

Abstract

Reconstruction of complex defects of the central abdomen is both challenging and technically demanding for plastic surgeons. Advancements in the use of pedicle and free tissue transfer along with the use of bioprosthetic and synthetic meshes have provided for novel approaches to these complex defects. Accordingly, detailed knowledge of abdominal wall and lower extremity anatomy in combination with insight into the design, implementation, and limitations of various flaps is essential to solve these complex clinical problems. Although these defects can be attributed to a myriad of etiologic factors, the objectives in abdominal wall reconstruction are consistent and include the restoration of abdominal wall integrity, protection of intraabdominal viscera, and the prevention of herniation. In this article, it is our goal to review pertinent anatomy, pre- and postoperative care regimens, and the various local, regional, and distant flaps that can be utilized in the reconstruction of these complex clinical cases of the central abdomen.

Keywords

- abdominal wall
- complex defects
- abdominal wall reconstruction
- anatomic zones

Reconstruction of complex defects of the abdominal wall is both challenging and technically demanding for plastic surgeons. Therefore, it is imperative that the operating surgeon is knowledgeable of the etiologies, pertinent anatomy, and proper postoperative care of these patients. Although these defects can be attributed to a myriad of etiologic factors, the objectives in abdominal wall reconstruction are consistent and include the restoration of abdominal wall integrity, protection of intraabdominal viscera, and the prevention of hernia or bulge formation while maintaining an aesthetically favorable result.¹

Abdominal Wall Defects

Etiologies for complex abdominal wall defects include trauma, oncologic processes, radiation necrosis, infection, postoperative incisional hernias, and congenital anomalies. Each of these etiologic factors provides for unique challenges in determining reconstructive timing and course. The decision

to pursue immediate versus delayed abdominal reconstruction is based upon patient comorbidities, etiology of the defect, wound contamination, and overall clinical condition. In most situations, immediate reconstruction is preferred secondary to physiologic advantages of closing the abdomen. However, immediate reconstruction is deferred in a myriad of situations including significant inflammation and infection, wound contamination, and concomitant medical or surgical comorbidities that prohibit surgery.

If abdominal reconstruction is delayed, temporary abdominal coverage can be achieved in several ways. Skin grafts can provide adequate, temporary closure for these patients while minimizing donor-site morbidity. In addition, vacuum-assisted closure may provide superior, temporary coverage for a wound bed while increasing vascularization and potentially decreasing bacterial colonization.² Finally, temporary abdominal closure can be achieved using bioprosthetic or synthetic mesh; either type of mesh provides support and protects the

intraabdominal contents while minimizing significant fluid losses and wound inflammation.

Anatomy

Skin and Subcutaneous Tissues

A thorough understanding of the anatomy of the abdominal wall is paramount when planning abdominal wall reconstruction. The integrity and quantity of skin and subcutaneous tissue is related to many factors such as age, body habitus, and previous surgery. Underlying superficial tissues can be grossly divided into skin, subcutaneous fat, Camper fascia, and the deeper Scarpa fascia. These superficial layers have important considerations when considering closure and wound care options.

Musculofascial Layers

An understanding of the musculofascial layers is critical to abdominal wall reconstruction. The rectus abdominis muscle and pyramidalis muscles are located anteriorly. Each rectus abdominis fuses at the midline to form the linea alba. The pyramidalis muscles are considered by many to be functionally insignificant triangular muscles and are present in approximately 80% of the population. The external oblique, internal oblique, and transversus abdominis muscles are located anterolaterally and fuse with the lateral aspect of the rectus abdominis bilaterally.

The arcuate line of the abdomen is a horizontal line that represents an important anatomic landmark with respect to the rectus sheath. Cranial to the arcuate line, the anterior rectus sheath is composed of the aponeuroses of the external oblique and anterior leaf of the aponeuroses of the internal oblique muscle. Similarly, the posterior rectus sheath is composed of the posterior leaf of the aponeurosis of the internal oblique muscle, the transverses abdominis muscles, and the transversalis fascia. Caudal to the arcuate line, the anterior rectus sheath is composed of the aponeurosis of the external and internal obliques and the transverses abdominis. At this point, the posterior rectus sheath is composed of the transversalis fascia only.

Blood Supply

The vascular supply to the abdomen can be subdivided into three zones based upon regional anatomy. A regional vascular map initially described by Huger provides a simplistic, yet reliable model for illustration.³ Zone I is located in the anterior midline portion of the abdomen in the vicinity of the rectus abdominis and is supplied by the deep epigastric arteries. Specifically, the superior and the deep inferior epigastric arteries supply the rectus muscle and the overlying skin and subcutaneous tissues. Zone II encompasses the caudal aspect of the anterior abdominal wall and derives its vascular supply from four main arterial systems. The superficial external pudendal and superficial epigastric arteries are both derived from the femoral artery and supply the superficial fascia and skin in this area. The inferior epigastric and deep circumflex arteries supply the musculature in this area. Zone III is described as the most lateral aspect of the

abdominal wall cranial and it derives its vascular supply from the intercostal and lumbar arteries, which arise from the aorta.

Patient Evaluation

History and Physical Examination

In addition to anatomic knowledge, it is essential to understand patient characteristics that could lead to potential complications in abdominal wall reconstruction. Accordingly, laboratory assessment as well as consultation from other services including general surgery, internal medicine, and nutrition plays a vital role in the successful outcome of the operation. In addition, aspects of a patient's past medical history such as peripheral vascular disease, diabetes mellitus, autoimmune disorders, and hematologic disorders can be associated with impaired wound healing and should alert the team to aggressively prevent these complications.

When acquiring a patient's history, it is important to focus on prior surgical history and prior abdominal wall radiation exposure. Prior abdominal surgery can compromise the ability to mobilize aspects of the abdominal wall. The presence of colostomies, ileostomies, and urostomies should alert the surgeon to the potential for wound healing difficulties as these have the potential to spread enteric bacteria throughout the defect. Furthermore, prior abdominal surgery can alter perfusion to the underlying fascia and potentially create visceral adhesions, which can complicate reconstruction efforts.⁴ Finally, prior radiation exposure can decrease wound-healing capacity and alter local tissue perfusion, two aspects that can further complicate abdominal wall reconstruction.

A careful assessment focusing on the patient's social history can provide guidance pertaining to pre- and postoperative care. Accordingly, social habits such as tobacco use and alcohol dependency can lead to impaired wound healing through vasoconstriction and immunosuppression, respectively. Attention should be paid to the patient's employment as heavy lifting can be contraindicated in these patients for prolonged periods and may impair the livelihood of patients engaged in manual labor. Finally, given the relatively long recovery time for many of these patients, a strong social support system should be in play to assist the patient in their recovery.

Preoperative physical examination should focus on factors such as body mass index and evaluation of potential donor sites for flap coverage. Weight reduction for obese patients is recommended to decrease complication rates, although this is not always feasible in the setting of traumatic abdominal wall repair. Furthermore, physical examination should focus on the potential suitability for flap harvest both cranial and caudal to the defect.

Wound bed evaluation should focus on establishing a clean and well-vascularized wound base. If the abdominal defect is an acute, uncontaminated wound, simple surgical debridement can prepare the surrounding tissues for adequate coverage. Chronic abdominal wounds require further evaluation prior to temporary or definitive coverage. The patient's

medical abnormalities such as coagulation abnormalities, glucose levels, and vascular deficiencies should first be addressed. Further aggressive debridement of devitalized tissue and eradication of microorganisms should be performed sequentially until the chronic wound is converted into an acute wound. At this point, the patient should have sufficient granulation tissue to pursue further reconstruction.

Imaging Studies

Abdominal computed tomography (CT) or magnetic resonance imaging (MRI) evaluation can identify the extent of the abdominal wall defect and the integrity of adjacent musculo-fascial structures to aid in preoperative planning. When using pedicled flaps from the abdomen, such as the vertical rectus abdominis myocutaneous (VRAM) or anterolateral thigh (ALT) flap, CT scans performed with contrast can delineate the vascular anatomy to these flaps. The deep inferior epigastric vessels can be seen clearly going to the rectus muscle and coursing through this structure. This preoperative finding allows the surgeon to make operative decisions ahead of time, especially if the patient has had previous surgery potentially damaging these vessels.⁵ CT angiography is invaluable in accurately identifying the abdominal wall vasculature when planning a free tissue transfer. This is of particular importance in the reconstruction of the radiated abdominal wall where vascular anatomy can be altered

significantly and perforating vessels can be difficult to localize. Recipient vessels for free tissue transfer along with pedicle vessels can be localized with routine CT angiography of the abdominal wall.

In conclusion, a careful assessment and a comprehensive workup may be required in some of the complex abdominal wall reconstruction patients. This approach will allow customizing the management for each individual patient and will help decrease postoperative complications.

References

- 1 Butler CE. The role of bioprosthesis in abdominal wall reconstruction. *Clin Plast Surg* 2006;33(2):199–211, v–vi
- 2 Weed T, Ratliff C, Drake DB. Quantifying bacterial bioburden during negative pressure wound therapy: does the wound VAC enhance bacterial clearance? *Ann Plast Surg* 2004;52(3):276–279, discussion 279–280
- 3 Huger WE Jr. The anatomic rationale for abdominal lipectomy. *Am Surg* 1979;45(9):612–617
- 4 Lin SJ, Butler CE. Subtotal thigh flap and bioprosthesis mesh reconstruction for large, composite abdominal wall defects. *Plast Reconstr Surg* 2010;125(4):1146–1156
- 5 Rozen WM, Ashton MW, Grinsell D, Stella DL, Phillips TJ, Taylor GI. Establishing the case for CT angiography in the preoperative imaging of abdominal wall perforators. *Microsurgery* 2008;28(5):306–313