

# Complex Abdominal Wall Hernias

## A New Classification System and Approach to Management Based on Review of 133 Consecutive Patients

Josef G. Hadeed, MD,\* Mark D. Walsh, MD,\* Theodore N. Pappas, MD,† Ivo A. Pestana, MD,\* Douglas S. Tyler, MD,† Howard Levinson, MD,\* Christopher Mantyh, MD,† Danny O. Jacobs, MD, MPH,† Sandhya A. Lagoo-Deenadlayan, MD,† and Detlev Erdmann, MD, PhD, MHSc\*

**Background:** Plastic surgeons are increasingly involved in the repair of complex ventral hernias. Although this typically involves recurrent incisional hernias, operative strategies can be applied to most abdominal wall defects, including chronic wounds with or without exposed mesh, enterocutaneous fistulas, or hernias associated with significant pannus formation.

**Methods:** This is a retrospective review of a single institution/single surgeon experience of complex ventral hernia repair performed over a 5-year period. Patients were classified into different hernia types based on their characteristics and underwent hernia repair according to the presented algorithm.

**Results:** A total of 133 patients underwent a complex ventral hernia repair between January 2005 and September 2009. The separation of components technique was used in the majority of cases. Permanent or biologic mesh was added in select patients. Adjunctive procedures were performed as indicated. The majority of short-term (less than 1 year) recurrences occurred in patients expected to have impaired wound healing due to comorbid conditions. In these patients, the recurrence rate was reduced when autologous repair was reinforced with mesh.

**Conclusion:** Autologous tissue is the preferred method for reconstruction of complex ventral hernias. In certain instances, such as contamination, use of an acellular dermal matrix mesh is added as a temporizing measure. A subset of patients who will be prone to recurrence remains. Long-term follow-up is needed to confirm reliable and reproducible results.

**Key Words:** hernia, abdominal wall reconstruction, complex abdominal wall reconstruction, complex hernias

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It is estimated that approximately 5 million Americans have an abdominal wall hernia.<sup>1</sup> In the United States, approximately 250,000 ventral hernias are repaired each year at a cost of \$2.5 to \$3 billion annually.<sup>2</sup> Ventral hernia remains one of the most common complications resulting from laparotomy, and is thought to be a

more common reason for reoperation as compared with bowel obstruction.<sup>3</sup> The true incidence of ventral hernia after laparotomy remains unknown, but varies on account of patient risk factors, surgeon experience, and disease process, and has been estimated at 2% to 11%.<sup>4</sup> Numerous retrospective analyses have identified risk factors for incisional hernia development and include chronic obstructive pulmonary disease, obesity, smoking, steroids, history of aortic aneurysms, and poor nutrition.<sup>5–8</sup> Superficial wound infections increase the risk of hernia, therefore, aggressive treatment should be used if postoperative wounds develop erythema and drainage.<sup>9</sup> Midline incisions have the highest rate of herniation with hernia formations usually occurring superior to the umbilicus.<sup>10</sup>

The indications for repair of ventral hernia are well established, and plastic surgeons are increasingly involved in the management of this complicated problem. It remains unclear, however, as to what the optimal technique for repair is and whether the repair itself should be reinforced. Further, if a repair is reinforced, controversies exist as to what type of material should be used and how they should be employed in the repair. Recurrence rates after hernia repair remain high despite recent advances in technologies and repair techniques. Approximately 50% of hernias recur after primary repair, and this rate is halved if synthetic mesh is used.<sup>11</sup> Additionally, not only does the risk of hernia recurrence increase with each operation, but the interval between reoperations also significantly shortens.<sup>12</sup>

The question remains: what is the optimal approach for managing complicated ventral hernias? The literature remains vague as to what type of repair is best. Further, there exist a multitude of products employed in hernia repair, and there is a lack of data comparing different techniques or materials. There is no consensus as to the preferred approach in complicated ventral hernia. In this review, the authors present their experience with ventral hernia repair at a single institution.

### PATIENTS AND METHODS

The study was approved by the Institutional Review Board of Duke University Medical Center. The investigators retrospectively reviewed a single surgeon (D.E.) series of ventral hernia repair performed between January 2005 and September 2009 at Duke University Medical Center. A total of 133 patients were identified, who underwent ventral hernia repair during this period. The following variables were recorded: patient factors (age, gender, smoking, diabetes, steroids, obesity), etiology of hernia, reconstruction type (component separation, component separation with mesh, mesh repair, primary repair), adjunctive procedures performed (panniculectomy), and outcomes (time to recurrence). Of the patients in the study, 129 had originally undergone a prior intra-abdominal procedure as a cause of their hernia. The remaining 4 patients had vertical rectus abdominis muscle free-flap transfer to the upper extremity, enterocutaneous fistula secondary to chemoradiation therapy, extra-

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From the \*Division of Plastic, Reconstructive, Maxillofacial and Oral Surgery, Duke University Medical Center, Durham, NC and; †Division of General Surgery, Department of Surgery, Duke University Medical Center, Durham, NC.

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Reprints: Josef G. Hadeed, MD, Division of Plastic, Reconstructive, Maxillofacial and Oral Surgery, Duke University Medical Center, Box 3974, Durham, NC 27710. E-mail: Josef.Hadeed@duke.edu.

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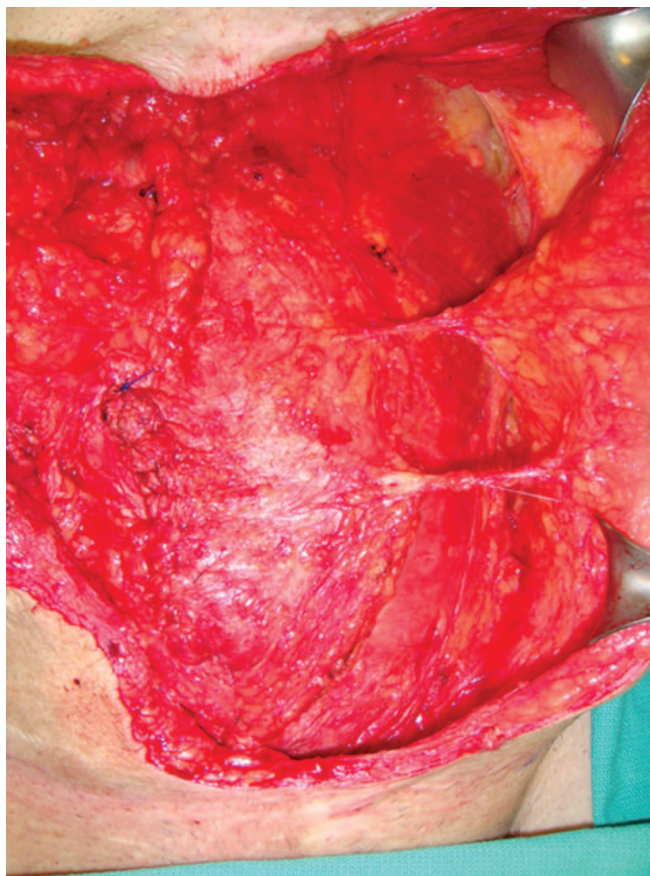
**TABLE 1.** Classification of Hernias Based on Patient and/or Hernia Characteristics

Hernia Type	Characteristics
I	Normal wound healing
II	Impaired wound healing
III	Contaminated wound
IV	Massive weight loss
V	Loss of abdominal domain

abdominal desmoid tumor resection, and metastatic disease to the abdominal wall as the etiology of their hernia. Electronic medical records from the hospital and office were reviewed. Recurrent hernias were defined by physical examination by the senior surgeon.

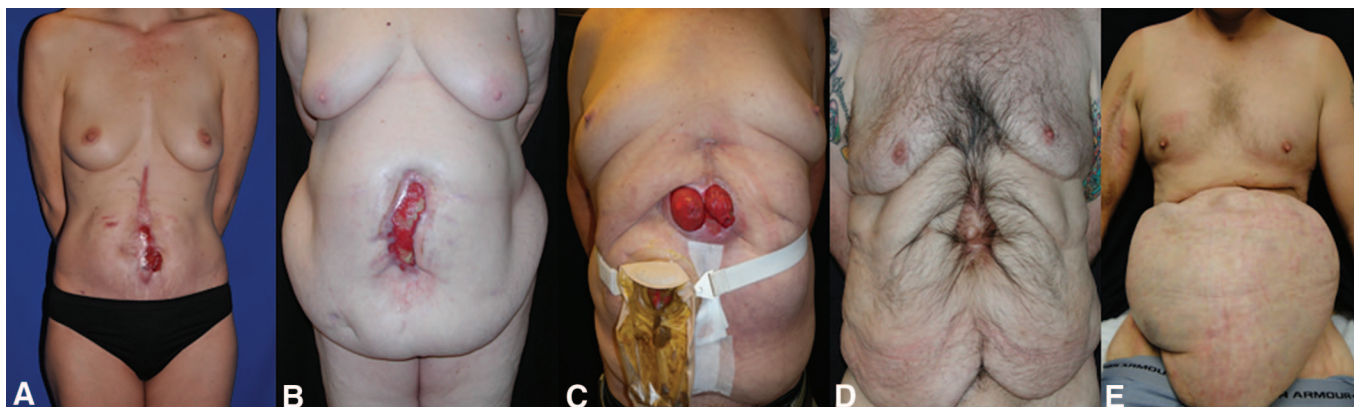
Patients were classified preoperatively into different hernia types based on the following parameters (Table 1): normal wound healing (Type I), impaired wound healing (Type II), contaminated wound (Type III), massive weight loss (Type IV), and loss of domain (Type V). The first category includes patients who are generally healthy and who have complex hernias that have failed attempts of repair, with or without prosthetic material (Fig. 1A). The second group of patients with complex ventral hernias is expected to have impaired wound healing either due to comorbid conditions, in particular obesity or other factors including diabetes mellitus, smoking, or therapeutic immunosuppression (Fig. 1B). The third group of patients includes patients with contaminated abdominal wounds, such as with infected mesh, enterostoma or persistent enterocutaneous fistula (Fig. 1C). The fourth category of patients involved those who have experienced massive weight loss, for example, after undergoing gastric bypass surgery (Fig. 1D). In addition to having increased risks of complications from poor wound healing, patients of this group may need significant concomitant resection of skin and benefit from a simultaneous panniculectomy or abdominoplasty procedure. The fifth category includes patients with a “loss of domain” with or without significant comorbidities (Fig. 1E).

Our operative technique for the components separation procedure was as follows: vertical incisions are made just lateral to the lateral aspect of the rectus sheath and are then carried superiorly to the xiphoid and inferiorly to the pubic symphysis, thereby releasing the external oblique. Blood flow to the skin was maintained by preserving perforating vessels as they were identified (Fig. 2). In patients in whom the separation of components could not achieve closure in the midline, mesh was used in an underlay manner; 0



**FIGURE 2.** Relaxing incisions are made lateral to the edge of the rectus sheath, and perforating blood vessels to the skin are preserved as they are encountered.

polypropylene sutures were placed in an interrupted fashion 3 cm from the medial edge of the rectus abdominis muscles bilaterally in such a manner so that the material was placed under maximal tension as specified by the manufacturer's recommendations. In general, synthetic mesh was used in noncontaminated cases and biologic mesh was employed in those situations in the presence of



**FIGURE 1.** Classification of hernias based on patient characteristics. A, Patients with normal wound healing, (B) impaired wound healing, (C) contaminated abdominal wounds, (D) after massive weight loss, (E) loss of abdominal domain.



contamination. Panniculectomies were performed in select patients by excising a significant amount of tissue (skin and fat) as indicated.

### Statistical Analysis

Patient characteristics between groups, technique of hernia repair according to hernia type, and rates of recurrence and complication rates based on technique of repair were compared using a  $\chi^2$  test for categorical variables and an analysis of one-way variance test for continuous variables. Results were calculated using Graph-Pad Prism (La Jolla, CA) software when indicated. A value of  $P \leq 0.05$  was considered significant in all analyses.

## RESULTS

There were a total of 133 patients who underwent ventral hernia repair during the study period at our institution performed by the senior author. Table 2 summarizes the patient characteristics in each group. There were 58 men and 75 women in the study. All patients with the exception of 4 had a prior history of intra-abdominal procedure, and 26 (20%) patients had a history of prior hernia repair. The classification of the patients were as follows: 23 (17%) patients were considered to have normal wound healing (Type I), 56 (42%) were considered to have impaired wound healing (Type II), 36 (27%) were considered to have a contaminated wound (Type III), 11 (8%) had undergone massive weight loss (Type IV), and 7 (5%) of the patients were considered to have complete loss of domain (Type V).

The categorization of hernia repair technique performed based on the hernia type is outlined in Table 3. The separation of component technique alone was used in 64 (48%) repairs. A separation of components with adjunctive mesh placement occurred in 39 (29%) repairs. Twenty-two (17%) of them had their hernia repaired with mesh only. Primary repair of the hernia was achieved in 8 patients (6%). A panniculectomy was performed as an adjunctive procedure with the hernia repair in 17 patients.

Table 4 outlines the recurrence rates as well as major and minor complications rates for each repair technique. A recurrence of the ventral hernia occurred in 22 patients (17%), with a mean time to recurrence at 10.4 months (range, 1–32 months). Major complications (defined as infection requiring operative intervention, reoperation for any complication related to the repair, pulmonary embolus, myocardial infarction, sepsis, and death) occurred in 13% of patients. Minor complications (defined as superficial wound infection, skin breakdown, or seroma) were seen in 10% of patients. Overall, 17% of patients experienced a complication other than recurrence.

Further subset analysis revealed that 10 of the recurrences (43%) occurred in patients considered to be at risk for poor wound healing, that is, type II hernia (obesity, active smoking, diabetes, or

concurrent steroid use). Nineteen of the recurrences (83%) were in patients who were considered obese (body mass index  $>35$ ). Further, 10 of 11 patients who were classified as having a type II hernia and had a recurrence were also obese. Eight recurrences (36%) occurred in patients with a prior history of hernia repair; of these, half were in patients considered to be at high risk for wound healing complications (type II hernia). The technique of component separation alone was performed in 64 patients (48%) who underwent ventral hernia repair during the study period. Hernia recurrence occurred in 10 patients (16%) undergoing component separation technique only. Of these patients, 9 (90%) of them were considered to be type II hernia (poor wound healing). Nine recurrences were in patients who had a mesh-only repair; all 9 of these patients were repaired using biologic mesh.

## DISCUSSION

Complex abdominal wall hernia repair continues to be a challenge to the reconstructive surgeon. Poor tissue quality, obesity, concomitant medical problems, contamination, and infection all pose potential obstacles to a successful repair. Multiple approaches have been attempted with various degrees of success. With all repair methods, however, there remains a subset of patients who will be prone to recurrence or other more short-term complications. Despite concerted efforts, it can be difficult preoperatively to predict recurrence, although certain patient characteristics are associated with increased risks.

Over the past 2 decades, data have emerged regarding the success of primary repair of ventral incisional hernias. Recurrence rates ranged from 20% to 60% and as many as 50% were found to have more than one area of defect.<sup>13,14</sup> A prospective, randomized clinical trial by Luijendijk et al (published in 2000) compared primary repair with mesh repair and revealed recurrence rates of 46% and 23%, respectively.<sup>11</sup> A long-term follow-up study of this data demonstrated a recurrence rate of 63% in the primary repair group and 32% for the mesh group at 10 years.<sup>15</sup> Flum et al showed that the length of time between reoperations for hernia recurrence was progressively shortened after each repair.<sup>12</sup> Given these results, many authors have advocated tension-free mesh repair over primary repair. A recent Cochrane meta-analysis confirmed a significantly higher incidence of recurrence after primary repair; however, more wound infections were observed in the mesh patient group.<sup>16</sup> For this reason, small hernias ( $<4$  cm) should be repaired primarily as long as it can be performed tension free.<sup>17</sup>

Complex ventral hernias are hernias requiring a distinct and more individualized, frequently interdisciplinary intervention beyond primary repair or the simple placement of mesh. These include recurrent hernias with multiple failed repairs, infection or other local

**TABLE 2.** Characteristics of Patient Who Underwent Ventral Hernia Repair

Baseline Characteristics	Group 1 n = 23 (%)	Group 2 n = 56 (%)	Group 3 n = 36 (%)	Group 4 n = 11 (%)	Group 5 n = 7 (%)	
Gender						
Male	10 (43)	22 (39)	20 (56)	1 (9)	5 (71)	
Female	13 (57)	34 (61)	16 (44)	10 (91)	2 (29)	$P = 0.0396$
Age, yr						
Mean	58.9	56.6	57.5	43.4	55.7	
Range	20–80	41–72	35–74	33–63	33–70	
SD	15.9	9.6	9.6	16.4	14.0	$P = 0.0071$
History of previous repair	5 (22)	10 (18)	7 (19)	3 (27)	1 (14)	
Simultaneous panniculectomy	0 (0)	5 (9)	2 (6)	7 (64)	3 (43)	

**TABLE 3.** Technique of Hernia Repair According to Hernia Type

Type of Repair	Group 1 n = 23 (%)	Group 2 n = 56 (%)	Group 3 n = 36 (%)	Group 4 n = 11 (%)	Group 5 n = 7 (%)	
Component separation	13 (57)	35 (63)	15 (42)	1 (9)	1 (14)	
Component separation plus mesh	7 (30)	8 (14)	17 (47)	3 (27)	4 (57)	
Mesh only	1 (4)	9 (16)	4 (11)	5 (45)	2 (29)	
Primary closure plus mesh	2 (9)	4 (7)	0 (0)	2 (18)	0 (0)	<i>P</i> = 0.0009

**TABLE 4.** Rates of Recurrence and Complications Based on Type of Repair

Type of Repair	No. Patients n = 133 (%)	Average Follow-up Months ± SD	No. Recurrences n = 23 (%)	Average Time to Recurrence Months ± SD	Major Complications n = 17 (%)	Minor Complications n = 13 (%)
Component separation	64 (48)	7.7 ± 8.4	10 (16)	9.9 ± 8.0	7 (11)	6 (9)
Component separation plus mesh	39 (29)	5.1 ± 6.7	3 (8)	12 ± 3.5	5 (13)	4 (10)
Mesh only	22 (17)	7.3 ± 6.2	9 (41)	8.4 ± 7.1	4 (18)	3 (14)
Primary closure plus mesh	8 (6)	3.9 ± 3.9	1 (13)	6.0	1 (13)	0 (0)
		<i>P</i> = 0.2386		<i>P</i> = 0.0524		

tissue compromise, inadequate soft-tissue coverage, and/or multiple sites of abdominal wall defects. A subset of patients requires concomitant procedures, such as enterostomy, and/or enterocutaneous fistula takedown, bowel resection, and/or specific plastic surgical approaches, including complex wound closure, panniculectomy, and abdominoplasty (including fascial plication). Patients with complex abdominal wall hernias have proven to be recalcitrant to simple mesh repair. The reasons for failure may be multifactorial, ranging from poor tissue to poor technique as well as exacerbating factors such as obesity. However, the operative goal remains to provide a definitive tension-free hernia repair in one procedure.

One of the main difficulties in approaching complex ventral hernias is the lack of consensus as to what the “best-fit” approach is. Reasons for this include a paucity of studies directly comparing techniques or products. Additionally, there are few randomized controlled trials addressing this topic and many of these studies are limited by short-term follow-up. Different surgical techniques can also contribute to the variable results seen. Certain patient characteristics may also affect outcome, regardless of the particular technique employed in the repair. For these reasons, the authors believe that guidelines can be used in the approach to tackling complex ventral hernia repair, but that the approach should be individualized for each patient while factoring in other considerations.

In our patient population, 133 patients underwent ventral hernia repair during the study period. Amongst them, 17% had a recurrence of their hernia and 17% had a complication of some sort, exclusive of recurrence. Obesity is known to be an independent predictor of infectious complications after hernia repair, and wound infection is a risk factor for hernia recurrence.<sup>18,19</sup> In this study, 83% patients who had a recurrence of their hernia were obese. Patients who were deemed preoperatively to be at poor risk for wound healing also had a high recurrence rate. In addition, half of the recurrences that occurred in patients with a prior history of hernia repair were in patients considered at poor risk for wound healing.

For defects that may not be amenable to primary closure, many authors advocate the separation of components technique as first described by Ramirez et al or variations thereof for reapproximation of the midline.<sup>20–23</sup> When examining the recurrences according to the technique of hernia repair performed, we found that 16% of patients who underwent a separation of components technique only had a recurrence of their hernia. This recurrence rate is

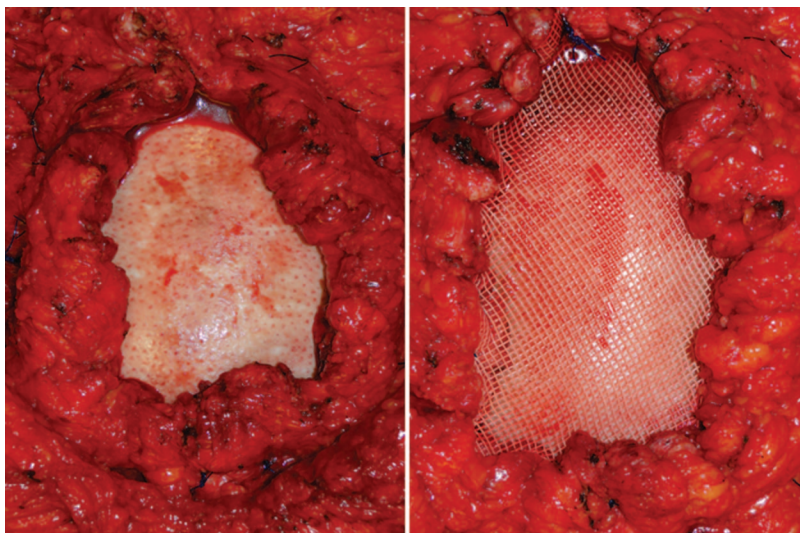
similar to what has been reported previously.<sup>23–26</sup> However, of these patients in our study who had a recurrence following the separation of components technique, 90% of them were classified as a type II hernia and at poor risk for wound healing. Although components separation technique can reduce hernia recurrence, some patient may benefit from the augmentation of their components separation procedure with a prosthetic mesh, especially in those patients with comorbidities, contamination, or any other complex defect. A recent review demonstrated a significantly lower recurrence rate in patients in whom components separation was augmented with synthetic repair material.<sup>27</sup> As the separation of components technique is an autologous repair that uses the patient’s own tissue, it is not entirely surprising that patients at risk for poor wound healing had a higher recurrence rate when their hernias were repaired using this technique alone. In these patients, consideration should be given to reinforcement of the components separation with prosthetic mesh. Indeed, when looking at our patients who had their hernias repaired using a combination of components separation plus mesh reinforcement, the recurrence rate dropped to 8%.

If mesh is used either alone or in combination with the components separation technique, should synthetic or biologic mesh be used? Synthetic mesh is easy to use and has a comparatively low cost to biologic mesh; drawbacks, however, include increased risk of visceral adhesions and/or enterocutaneous fistula, and infection of the material itself.<sup>28–30</sup> Allograft or xenograft (acellular dermis) materials are clearly more expensive than prosthetic mesh. The authors believe their use is justified for several reasons. First, several patients are undergoing concomitant procedures with the potential for transient contamination. If prosthetic mesh was solely considered, the procedure would either have to be aborted or a mesh contamination would inevitably occur. Second, if there is any superficial wound breakdown, there is no risk of exposed mesh. With or without utilization of the vacuum-assisted closure (KCI, San Antonio, TX) system, the dermal matrix becomes incorporated and consequently it is more resistant to infection. The upfront costs may be justified if utilization leads to fewer future complications and decreased readmission or revision surgeries.

There are instances, however, in which biologic mesh should not be used alone for the repair of complex hernias. In our population, 100% of the patients who had their hernia repaired with biologic mesh only experienced a hernia recurrence. This is similar



**FIGURE 3.** A 42-year-old man with a large ventral hernia and presence of a stoma (above, left). A components separation was performed and approximation was not possible in the superior aspect. Acellular dermal matrix was placed in an underlay fashion (above, right). Result 6 months postoperatively, seen from in front and from the side. Note the recurrence of the hernia in the superior aspect of the abdomen, where the acellular dermal matrix has been placed (below, left, and right).



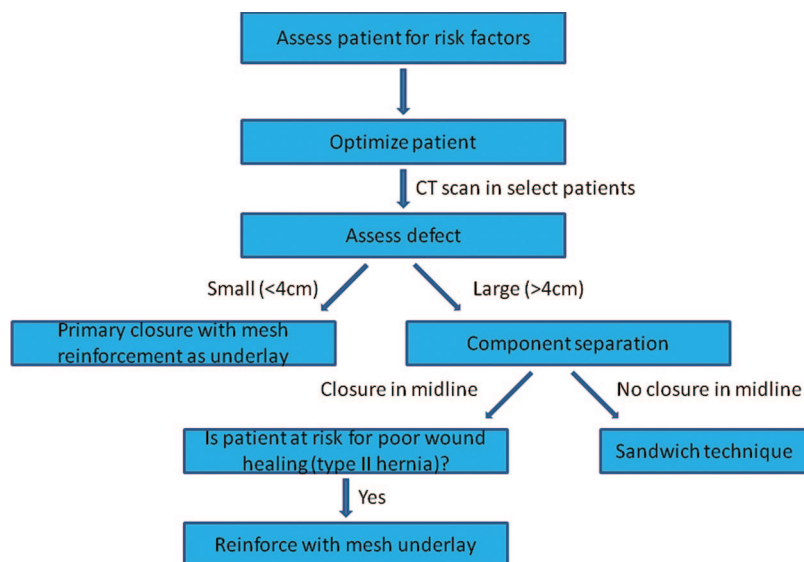
**FIGURE 4.** The sandwich technique employed when reapproximation of native tissue in the midline is not possible. Acellular dermal matrix is placed in an underlay fashion (Left). Prosthetic mesh is placed on top (Right).

to that which has been reported previously.<sup>31</sup> We therefore recommend that when mesh is used by itself to repair a midline defect, synthetic mesh should be employed in the absence of contamination. If contamination is present, biologic mesh can be used temporarily in a bridging fashion to restore abdominal wall integrity in contaminated fields, expecting an early partial hernia recurrence (Fig. 3). If used as an adjunct to close the gap remaining after components separation, a sandwich technique utilizing biologic mesh and a synthetic implant are used in both an underlay and overlay fashion (Fig. 4). If the components separation technique results in reapproximation of the midline, and reinforcement is necessary, biologic mesh should be used in an underlay fashion.

The authors concede that there are several limitations to this study. It is retrospective in nature, and along with it all the limitations inherent in a retrospective review. A prospective analysis of patients with preoperative classification into different hernia types would help to further validate outcomes. The average follow-up for all patients was 6.6 months, and conclusions regarding long-term outcomes are limited. However, our data demonstrate that utilizing a components separation technique only in patients at risk for poor wound healing has a short-term failure rate, which provides for our recommendation to augment the repair with mesh in this situation. Nonetheless, more long-term follow-up is needed. We also believe that one of the strengths of this review is that all operations were performed by the senior author. This potentially reduces the variability in outcomes related to surgical technique.

Given the lack of well-controlled randomized, prospective trials and comparative studies looking at different repair techniques and products, it is difficult to know at this point what is considered the “best” approach to complex ventral hernia repair and abdominal wall reconstruction. Recently, the Ventral Hernia Working Group published their recommendations on complex ventral hernia repair.<sup>32</sup> Their recommendations were borne from the lack of consensus in the literature regarding optimal repair technique, choice of materials, and risk stratification for surgical site occurrence. We agree with their recommendations, and have developed an algorithm based upon our institutional experience with complex ventral hernia repair that is similar to that from the Ventral Hernia Working Group, with a few modifications (Fig. 5). We agree that initially, the patient’s risk factors should be assessed and the patient should then be optimized for surgery as best possible. Abdominal computed tomography scanning is considered preoperatively to better characterize the degree of the abdominal wall defect in select patients; for





**FIGURE 5.** Algorithm used for repair of ventral hernia.

example in severely obese patients in whom the defect may be significantly underappreciated on physical examination. This also helps to estimate the size of the abdominal defect, although often this assessment is made intraoperatively.

We further agree with the Ventral Hernia Working Group that if the defect is small enough to be closed primarily, it should be reinforced with the type of mesh (synthetic vs. biologic) according to presence or absence of contamination and/or infection. If the defect is too large to be closed primarily, our preference is to perform a unilateral or bilateral separation of components as indicated to minimize tension or the use of foreign material. To prevent skin ischemia and subsequent necrosis, the abdominal wall skin and subcutaneous tissue is mobilized only to the amount necessary to identify the lateral border of the rectus sheath. Large perforators to the skin are identified and left intact if possible, as this has been shown to reduce the incidence of postoperative wound complications.<sup>33</sup> We believe that in patients without risk factors for wound healing, the separation of components is sufficient for repair if the fascia is able to be approximated in the midline. In patients who are predisposed to poor wound healing, however, we recommend reinforcing the components separation repair with an underlay mesh based on our high failure rate in this subpopulation. If medialization of the rectus fascia is not possible, synthetic material will be used to replace missing tissue in the absence of contamination/ infection, or an open alimentary tract. Often in complex hernia or abdominal wall repair, however, the risk for contamination including enterostomy takedowns, removal of infected mesh, or repair of enterocutaneous fistula precludes their utilization. In this scenario, acellular dermal matrix, such as Permacol (Covidien, New Haven, CT) or Strattice (LifeCell, Branchburg, NJ), is used. This material is placed as per the manufacturers' instructions in an underlay fashion on the peritoneal side of the fascial defect, with a minimum of 3 cm overlap of healthy fascia. The sandwich technique is usually used in this situation. Alternatively, if the fascia closes primarily but appears weak or attenuated, an underlay of prosthetic mesh or acellular dermal matrix for reinforcement of questionably compromised fascia can be used. In certain instances, eg, contamination or infection, biologic mesh may be used in a temporary, "bridging" fashion. At the time of skin closure, generous resection of skin and subcutaneous tissue is performed, leaving only the amount necessary for closure. For those patients who have undergone massive weight loss, we perform an adjunctive modified panniculectomy procedure.

Further frontiers in abdominal wall reconstruction include the use of composite tissue allotransplantation for refractory cases with severe tissue loss. When performed in conjunction with small bowel transplantation, it successfully facilitates abdominal wall closure in a difficult group of patients.<sup>34,35</sup> It is natural to extrapolate its use for already immunosuppressed patients, that is, previous transplant recipients with complex abdominal wall defects. Our center is currently one of few in the country with institutional review board approval for the use of an abdominal wall composite tissue allotransplantation in immunosuppressed patients with severe abdominal wall defects. With further understanding of immune response and advances in creating immune tolerance, abdominal wall transplantation might become standard therapy with severe loss of abdominal domain.

## CONCLUSIONS

Complex ventral hernia repair continues to remain a challenging problem to the plastic surgeon, despite the gains in our understanding of this common surgical problem. No ideal method exists, and despite recent advances in surgical products and repair technique, the recurrence and complication rates remain high. The approach to each patient should be individualized to optimize outcomes. More long-term studies and follow-up are needed to address the ideal approach to this challenging surgical dilemma.

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