ABDOMINAL WALL RECONSTRUCTION

CHAPTER 50

Predicting Poor Outcomes in Abdominal Wall Reconstruction

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INTRODUCTION

Advances in trauma management and operative techniques, as well as cutting-edge management of intra-abdominal catastrophes lead to enhanced patient survival, but challenging hernias as the sequelae. Hernia surgeons and plastic surgeons are saddled with increasingly complex abdominal wall reconstruction, often for whom there have been multiple prior attempts.[1,2] Sometimes, a routine hernia repair can cascade into a complex infected wound and also require innovative methods to repair. Despite applying the best and most advanced techniques for abdominal wall reconstruction, the surgeon may still be faced with devastating postoperative complications. Postoperative complications such as superficial and deep infections, wound dehiscence, and hernia recurrence lead to significant morbidity and mortality in these complex procedures in already high risk patients.[3] In this chapter, we will discuss risk factors for and predictors of poor outcomes and ways to manage or minimize them.

Poor outcomes range from relatively minor complications such as superficial wound infection, seroma, and hematoma, resulting in the need for local wound care or minor re-operative intervention to more major complications such as skin flap necrosis, deep wound infection, or hernia recurrence. In addition, there can be postsurgical systemic complications from the physiologic burden of a complicated procedure such as abdominal compartment syndrome, renal failure, and inability to wean from the ventilator. While many complications may be related to patient comorbidities, surgical technique and intraoperative decisions also play a role in poor outcomes.

PATIENT SELECTION

Factors that predispose patients to hernia formation following abdominal surgery also predispose them to complications after hernia repair. Risk factors for herniation and subsequent complications include active smoking or recent smoking history, obesity, and chronic systemic conditions such as diabetes mellitus, chronic obstructive pulmonary disease (COPD), immunosuppression for management of transplant status or autoimmune diseases, and connective tissue diseases. In separate publications, Dunne et al and Finan et al analyzed records from the National Surgical Quality Improvement Program (NSQIP) database and determined that several comorbid conditions were independent risk factors for increased postop infection and patients with comorbidities such as COPD, steroid dependence, smoking, and low preoperative serum albumin had a fourfold increase in wound infection rates.[4,5] Once the decision is made to operate, preoperative risk factors must be carefully evaluated and optimized prior to preforming this elective procedure.

It is well known that postoperative complications are significantly higher in smokers. Nicotine is a potent vasoconstrictor that also decreases red blood cell, fibroblast, and macrophage presence in the wound. Independently, it also increases platelet aggregation and thus thrombosis at the microvascular level. Combustion products from smoking such as carbon monoxide and hydrogen cyanide decrease oxygen transport and metabolism, all of which lead to impaired wound healing.[6] Large ventral hernia repairs are usually elective as incarceration is less common, and thus there is time for patients to enter smoking cessation programs prior to surgery. Even 1 month of abstinence prior to surgery reduces the risk of wound complications. To insure smoking cessation, cotinine 1 week preoperatively or a caboxyhemoglobin level in an arterial blood gas (ABG) on the morning of surgery can be checked. Postponing surgery if elevated levels are found, is an option. Nicotine patch or gum, while useful in stopping the pulmonary issues of smoking, still contributes to the nicotine-mediated complications, and as such, patients should ideally be smoking-free and nicotine-free. Smoking has been found to be an independent risk factor for complications, specifically mesh infection in hernia repair.[7] Sorensen et al found that the rate of infection in smokers was 12% compared

with 2% in nonsmokers.[8] Second hand smoke exposure is also detrimental and family members should likewise be encouraged to stop smoking prior to the procedure.

There is no consensus on patients presenting for hernia repair after significant weight loss through diet or weight loss surgery. Massive weight loss can lead to significant nutritional deficits which impact wound healing. Serum protein, transferrin, prealbumin, albumin, and reticulocyte index should be obtained to determine the patient's short- and long-term nutritional status. Depending on the type of weight-loss surgery the patient underwent, supplementation with both micro- and macronutrients may be indicated. In particular, patients should be checked for adequacy of vitamins A, D, K, B12, and folate, as well as calcium, zinc, selenium, and thiamine and supplemented if indicated. Similarly, patients who have significant alcohol consumption can present with nutritional deficits. Elective abdominal wall reconstruction should be delayed until nutritional status is optimized. Patients with low albumin should be placed on a protein rich diet with additional supplementation as appropriate. Patients who are overweight should be encouraged to enter diet and exercise programs in an effort to lose weight prior to surgery. Even small weight reductions in the obese patient can make the procedure technically easier by increasing abdominal domain and decreasing pulmonary deficits and should be encouraged in healthy, functional patients who have the necessary nutritional reserve.[9]

Cirrhotic patients with refractory ascites present another quandary. In patients who are eligible for liver transplant, a compression garment should be used to temporize until the hernia can be repaired at the time of transplantation. Close coordination between the transplant team and the reconstructive team can lead to higher success rates since the hernia closure is incorporated into the postoperative closure with ancillary techniques such as component separation and the use of supporting biologic or synthetic meshes. If the patient is not eligible for transplantation, hernia repair should be done after the ascites has been treated with medical management such as fluid and salt restriction, therapeutic paracentesis, peritoneovenous shunting, or transjugular intrahepatic portosystemic shunt (TIPS). Multiple surgical drains should be placed to allow initial healing at the time of hernia repair. Biologic mesh rather than synthetic mesh is preferred, although since biologic meshes are initially permeable to fluid, excessive transudate is to be expected from the drains and it may be preferred for drains to be connected to wall suction for the initial 24 to 48 hours.[10] Hernia repair in patients with carcinomatosis should be avoided unless done purely for palliation.

Deep vein thrombosis prophylaxis, chemical and/or mechanical should be used in all patients undergoing hernia repair. In patients at particularly high risk for deep venous thrombosis (DVT) and subsequent pulmonary thromboembolic events, such as history of prior DVT or pulmonary embolism (PE), cancer, or a hypercoaguable state, a removable inferior vena cava (IVC) filter to prevent PE, not DVT, may be considered. Implantation of the IVC filter, either temporary or permanent, carries its own set of risks and should be discussed with the patient, internist, hematologist, and interventionalist.

Many patients who present with large ventral hernias have had multiple failed attempts at repair. There is often retained, colonized, exposed, or infected mesh. Many have been on long-term antibiotics and have had multiple hospitalizations. In addition to removing all old mesh and sending it for culture, patients with a proven or suspected history of antibiotic resistant organisms should be pretreated with nasal bactroban to minimize risk of seeding with multi-drug resistant organisms.

The patient with inflammatory bowel disease (IBD; Crohn's or ulcerative colitis) represents a challenge because they are often: a) prone to recurrent bouts of underlying disease, b) can anticipate likely future surgery, c) are on immunosuppressant medications, and d) may be malnourished. Prior to repairing a hernia or recurrent hernia, adequate control of the IBD must be obtained working collaboratively with the gastroenterologist. Immune suppression must be minimized within the parameters of controlling the disease. There is a role for preoperative administration of vitamin A to help counteract the deleterious wound healing effects of corticosteroids. Nutrition must be optimized, whether it is via enteral or parenteral means, providing not only caloric support but also proteins and essential micro- and macronutrients. In anticipation for future surgery, versatile techniques such as component separation should be utilized, and an argument can be advanced to avoid a synthetic mesh prone to bacterial seeding in this situation.

SURGICAL TECHNIQUE

There are a variety of techniques used to reclaim lost abdominal domain and repair large abdominal wall defects. Depending on the size of the defect, procedures range in difficulty from simple approximation of the fascia without mesh to component separation with biologic or prosthetic mesh placement. Studies have shown that outcomes are

better when done in a high volume center with experienced surgeons and sophisticated hospital resources including experienced intensive care and medical specialists. Furthermore, the best likelihood of remaining recurrence free is with an adequate initial operation. Each successive operation, because it is additive of scarring and devascularization, has a poorer prognosis. Some of this is related to the inherent underlying nature of the disease–those that fail repair have higher comorbid factors, but even adjusting for confounders, a study by Flum shows that the survival curve for success is lower for each subsequent abdominal wall reconstruction.[11]

Approximation of the midline fascia in a tension free manner is performed to decrease the risk of recurrence and improve core muscle function. Simple repair without mesh reinforcement is reserved for the simplest cases with defect size less than 3 cm, otherwise this technique results in unacceptably high recurrence rates. In larger defects, component separation has been clearly shown to decrease the rate of recurrence when compared with direct closure.[12] Further, it creates a functional dynamic reconstruction, as opposed to simply a static reconstruction. It is sometimes possible to spare perforators, which protect the large skin flaps required for an open component separation, by using techniques such as periumbilical perforator-sparing technique,[13] minimally invasive component separation,[14] or laparoscopic techniques.[15] Previous abdominal surgery with multiple abdominal wall scars can compromise the abdominal wall blood supply if perforators are not spared and lead to skin, muscle, and fascial necrosis. Again, those at greatest risk for skin necrosis are the diabetic, obese, and smokers.

Despite component separation, approximation of the fascia at the midline may still be difficult or impossible. While primary fascial closure is superior, it should be avoided and interpositional mesh should be placed if there is a significant rise in intra-abdominal pressure. Although the pressure may not rise such that it causes bowel necrosis, it may rise enough to impair renal or respiratory function and increase the risk of deep venous thrombosis secondary to decreased venous return. Peak airway pressures should be evaluated prior to closure to avoid unacceptably high abdominal hypertension or compartment syndrome. Recent studies suggest that elevation of plateau airway pressure is the more significant parameter in predicting postoperative pulmonary complications.[16] Bladder pressures can also be monitored in the postoperative period but are a more gross measurement. Patients with an interpositional biologic mesh should be counseled that a bulge, distinct from a true hernia, in the abdominal wall may occur months to years following surgery. Should a bulge develop, the abdominal wall can be reinforced with a piece of synthetic mesh or imbrication, plicating it in if there has been an interval weight loss or increase in native abdominal wall compliance.

When reapproximation of the fascia at midline is possible, reinforcement of the midline repair with mesh further reduces the risk of recurrence. Mesh is now used in over 80% of ventral hernia repairs.[17] Prosthetic mesh is indicated in a clean environment with low risk of infection or wound complications—grade 1 ventral hernias. The advantages of synthetic mesh include reduced recurrence rate and low cost. However, they are associated with devastating complications such as fistula formation and infection. Biologic mesh is recommended for grades 2, 3, and 4 ventral hernias or patients with comorbid conditions, potentially contaminated wounds, and contaminated wounds. While expensive, biologic mesh allows vascular ingrowth, decreasing the risk of infection and permitting nonsurgical management of local wound infection. Initial costs may be offset with the decrease in downstream costs of managing complications. There is no clear consensus on whether underlay or overlay decreases rate of recurrence. Onlay mesh is technically easier and is associated with shorter operative times.[18] Mesh placed as an underlay in the retrorectus position has the advantage of an additional layer between the bowel and the incision.

Concurrent panniculectomy has been advocated by some surgeons as a way to decrease the rate of wound complications. A recent study by Zemlyak et al did not show a statistically significant difference in wound complications in patients who underwent concurrent panniculectomy and ventral hernia repair. However, they did experience a slightly higher rate of cellulitis when complications were broken down by type.[19] Soft-tissue complications can open a portal for deeper complications; loss of integrity of the skin's barrier function may seed a deeper seroma, inoculate a synthetic mesh, or lead to desiccation and deeper tissue necrosis. When a midline approach is planned, patients with prior Kocher, paramedian, and chevron incisions may develop soft-tissue compromise, especially if skin flaps are undermined. Judicious debridement of nonvital tissues at the time of closure can minimize downstream postoperative soft-tissue complications. Judgment of perfusion based on clinical assessment and experience may be enhanced by using tissue-perfusion measurement adjuncts such as angiography, tissue oximetry, or indocyanine green laser angiography.

Complex abdominal wall reconstruction requires the creation of large flaps and with multiple planes between layers of tissue. Fluid can collect between tissue planes, impairing integration of the mesh and wound healing. There are several methods that can be used to obliterate dead space and decrease seroma formation. First, it is critical to place the mesh on significant tension such that there is no rippling. Second, quilting sutures from the mesh to the abdominal wall, between the mesh and the skin flaps, as well as progressive tension sutures toward midline of the abdominal skin flaps, help to decrease dead space and promote good contact of vascularized tissue with the yet to be vascularized biologic mesh.[20] Finally, closed suction drains should be placed both above and below the mesh to further decrease risk of seroma.[21,22]

Necrosis of the skin flaps and wound breakdown are often the result of poor perfusion due to extensive undermining and closure under tension. Limiting undermining and preserving large perforators from the rectus may help to decrease the incidence of wound complications. Clinical assessment of the bleeding skin edge remains the gold standard; however SPY (Novadaq Technologies, Mississauga, Ontario, Canada) can be used as an adjunct to assess tissue perfusion to the skin edges and guide resection of nonviable skin and fat.[23,24]

Recent studies have shown the benefits of the application of negative-pressure therapy on abdominal wound incision after large hernia repair. These benefits include: promoting a moist wound healing environment; increasing granulation tissue, fluid evacuation and angiogenesis; minimizing edema, maintenance of a sterile field, and creation of a splint effect helping to distribute wound tension. Overall, patients treated with this device have experienced a decrease in wound complications such as infection, wound dehiscence, and a faster recovery. Negative-pressure wound therapy has also had favorable results on closed wounds in trauma populations.[25] Similarly, in a retrospective review of patients treated with negative-pressure wound therapy at this institution, the incidence of postoperative complications was 17% compared with a complication rate of 48% in patients treated with standard incisional care.[26]

One of the most challenging risk factors to recognize is the patient with a collagenopathy, such as Ehlers-Danlos and others. The multiply recurrent hernia patient with signs and symptoms suggestive of a collagen-vascular disorder, such as joint hypermobility should be screened. A full discussion of the extent of collagenopathies is beyond the scope of this chapter, but a timely referral to a rheumatologist would be indicated. Similarly, the patient with a Marfanoid body habitus should be screened not only for collagen disorder, but also for aortic aneurysm. Certainly, if the diagnosis of a collagenopathy is established preoperatively, for instance, in a known Marfan's patient, then precautions must be taken to minimize healing complications.

The presence of a stoma confounds definitive repair for several reasons: 1) there is the presence of increased bioburden in close proximity to the wound, 2) an ostomy is de facto a defect in the fascia. To begin, it is critical to carefully prep the ostomy, but then sterilely sequester it with ioban or another impervious cover. When placing mesh to support the closure, a keyhole technique (making a slot in a large piece of mesh to allow passage of the stoma) can be helpful, rather than piecemeal repair of hernia and parastomal regions separately. This *unibody* type repair is likely to decrease future hernia recurrence. While parastomal hernias are discussed elsewhere in this tome, it should be noted that the Sugarbaker technique and/or keyhole technique should be employed as a method of decreasing the risk of recurrence.

Although studies from oncology centers do not show higher hernia recurrence rates in irradiated patients or higher soft-tissue complication rates, the rate of enterocutaneous fistulae formation is about tenfold higher in irradiated patients. Invariably, the previously irradiated patient requires musculocutaneous flaps for reconstruction such as local rectus abdominis flaps/component separation, or regional flaps such as tensor fascia lata, rectus femoris, anterolateral thigh flaps, or remote free flaps to facilitate proper healing. Postoperative soft-tissue complications may need hyperbaric oxygen therapy, which has been shown to expedite wound healing in the setting of radiation. In addition, patients who have received radiation may also be receiving concomitant chemotherapy, providing another challenge to wound healing.

SUMMARY

Ultimately, many hundreds of small incremental steps need to be done correctly to achieve a favorable outcome in complex abdominal wall reconstruction. Obstacles to success abound, but if they are recognized preoperatively, intraoperatively, and postoperatively, they can be optimized and their deleterious effects mitigated.

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