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Abdominal wall reconstruction

Strategies to enhance outcomes

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Improving surgical outcomes is a priority in the healthcare environment. The reasons for this are related to reducing unplanned surgeries, untoward events, and hospital costs and improving patient satisfaction. The surgical management of patients with a ventral incisional hernia following laparotomy remains one of the most challenging situations associated with an increased rate of hospital readmission and hernia recurrence. Many patients with ventral incisional hernias suffer a variety of underlying comorbidities, such as obesity, pulmonary disease, diabetes mellitus, cardiac disease, and tobacco use. Often, patients with ventral incisional hernias are placed in a high-risk category because they are prone to surgical site infections (SSIs), surgical site occurrence (SSO), readmission, and recurrence.

Most studies that have evaluated long-term outcomes in patients following ventral hernia repair have reported recurrence rates up to 40% at 2 years and adverse events in over 50% of patients.[1,2] As a result, various strategies for preoperative optimization, intraoperative technical innovations, and postoperative care have been developed to assist with enhancing surgical outcomes following abdominal wall reconstruction (AWR). This article will review some of these innovations and treatments.

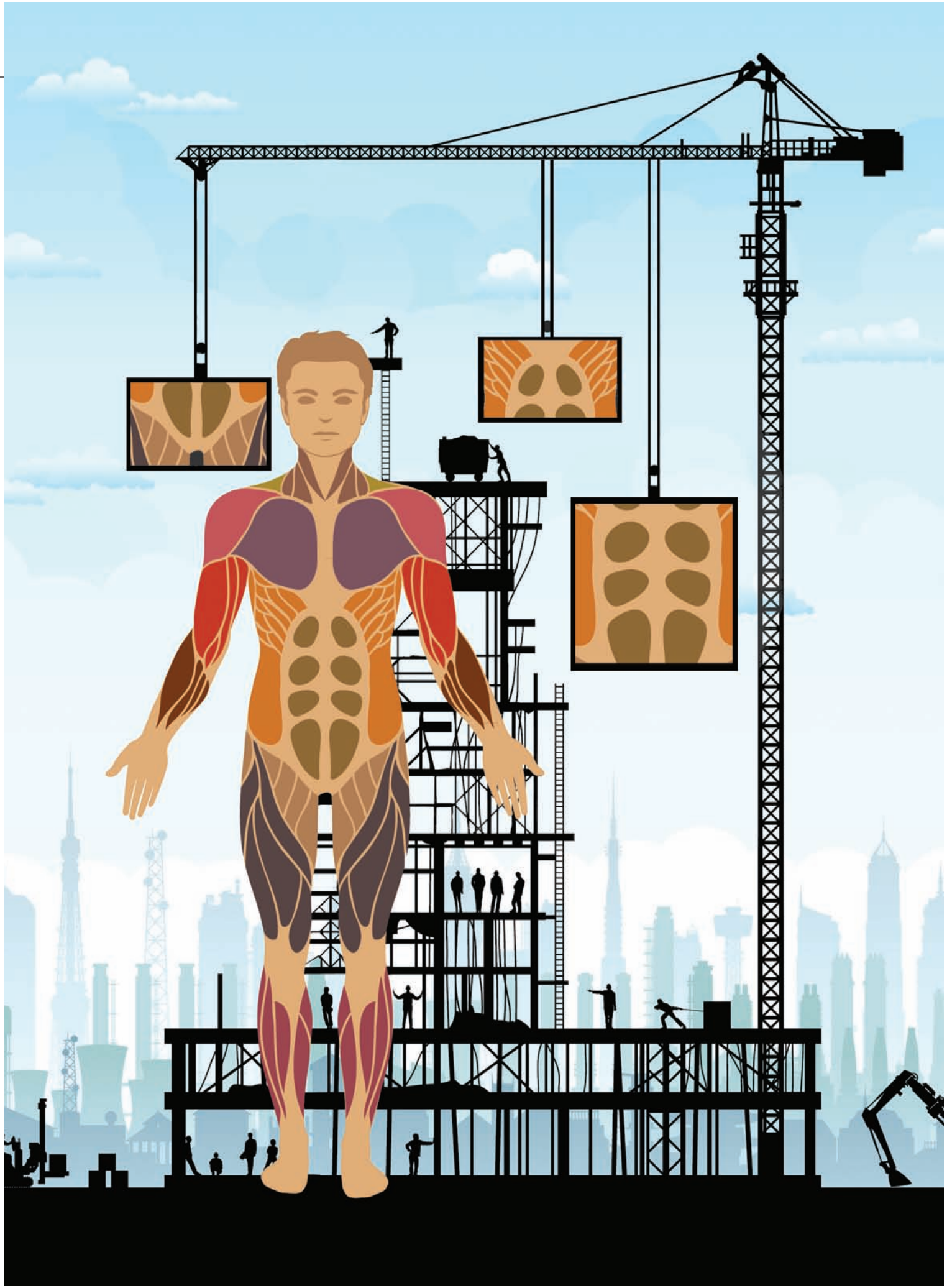
Preoperative considerations

The preoperative evaluation of the patient with an abdominal wall hernia is important. Many of these patients have comorbidities that may impact on outcomes. For example, tobacco use, diabetes mellitus, pulmonary disorders, obesity, or poor nutritional status can impede optimal wound healing, predispose the patient to infection, and ultimately lead to hernia recurrence. A classification system that addresses these comorbidities and stratifies the risk of an adverse event following surgery is helpful to improve outcomes (see *Grading scale to determine SSO after ventral hernia repair*).[3,4]

Tobacco cessation

The untoward effects of tobacco use in surgical patients are well known.[5,6] Nicotine is a powerful vasoconstrictor and will impact circulation at the level of the capillaries and small vessels. Carbon monoxide in tobacco binds to hemoglobin with high affinity and will readily displace oxygen, creating a hypoxic environment. Wound-related complications are more likely to occur and ultimately compromise the surgical outcome. It is critical that patients be well informed of these risks and the absolute need to stop smoking prior to surgery. Perioperative nurses serve an important role by properly educating and informing patients of the risks associated with tobacco use. It is recommended that patients be free from tobacco products for 1 month prior to surgery and for 2 weeks following surgery.[5]

Dimick demonstrated that overall costs associated with pulmonary complications can increase by



$52,000 per surgery in patients who smoke.[6] Coon found that patients using tobacco products had significantly higher overall complication rates, tissue necrosis rates (*P* less than 0.02), and were more likely to require reoperation.[7] Various strategies have been proposed to assist with smoking cessation, including nicotine-containing chewing gum, smokeless tobacco, nicotine patches, nicotine lozenges, and nicotine sprays. Individual and group counseling sessions are also effective.

Controlling diabetes mellitus

Poorly controlled diabetes mellitus is a well-known factor associated with poor healing.[8] Hyperglycemic states can interfere with normal wound healing and contribute to increased infection rates. Poorly-controlled diabetes mellitus is also associated with increased rates of soft tissue infection that can have significant consequences—especially in patients having AWR.[8] Patients with diabetes mellitus being considered for AWR should have a thorough lab assessment, including serum blood glucose, hemoglobin A1C (A1C), and urine glucose. Endara and colleagues, conducted a study on 79 patients having primary wound closures (the majority were lower extremity closures) and found that the risk of dehiscence increased as the patient's maximum preoperative blood glucose level increased.[8] Patients who had a preoperative blood glucose level less than 200 mg/dL had a 19.3% dehiscence rate after surgery compared to a 43.5% dehiscence rate in patients who had a preoperative blood glucose level greater than 200 mg/dL.[8]

In the same study of patients with extremity wounds and diabetes mellitus, Endara and colleagues also found that elevated levels of A1C were associated with compromised wound healing. A1C levels in excess of 6.5 demonstrate a statistically significant (P = 0.04) association with increased rates of incisional dehiscence (55.6% versus 26.1%). An A1C level of 6.5 was also associated with a trend toward increased rates of reoperation (33% versus 17.4%).[8]

Other comorbidities

Patients with a body mass index (BMI) over 30 are at higher risk for adverse events, such as delayed healing, seroma, infection, and incisional dehiscence.[9] It is therefore recommended that patients lose weight prior to having elective surgery. Patients with a BMI between 30 and 39 are carefully selected and decisions for surgery are based on the number of comorbidities and a risk evaluation. Many patients with a BMI greater than 40 have demonstrated higher rates of reoperation and recurrence leading to poor surgical outcomes. Although obese and morbidly obese patients often seem like they are adequately nourished, many are actually malnourished based on serum albumin levels.[10] Certain nutritional supplements, such as arginine and fish oil, have been shown to reduce infections and length of hospitalization.[11]

Pulmonary disorders can be life-threatening in patients requiring AWR. Placement of the abdominal viscera back into the peritoneal cavity will increase intra-abdominal pressure, elevate the diaphragm, and ultimately restrict pulmonary compliance. This can result in decreased oxygenation of the blood, tissue hypoxia, and delayed healing.

Operative strategies

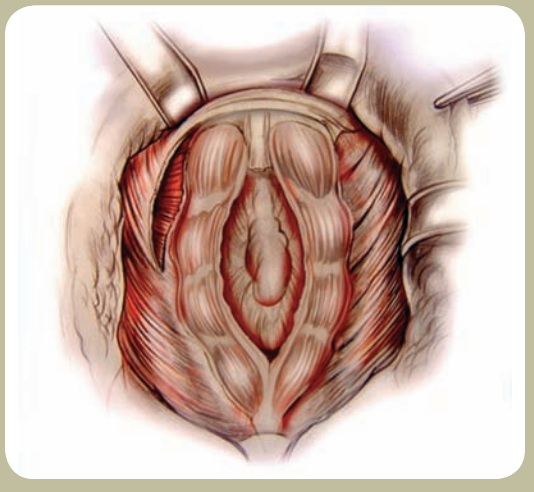
Optimizing surgical outcomes in the setting of ventral incisional hernia repair and AWR depends on patient selection, proper surgical technique, and

Grading scale to determine SSO after ventral hernia repair[4]

Grade 1	Grade 2	Grade 3
Low risk	**Comorbid conditions**	**Contaminated wounds**
Low risk of complications	Smoker	Clean contaminated wound
No history of wound infection	Obese	Contaminated wound
SSO = 14%	Chronic obstructive pulmonary disease	Dirty wound
	Diabetes mellitus	**SSO = 46%**
	Prior wound infection	
	SSO = 27%	

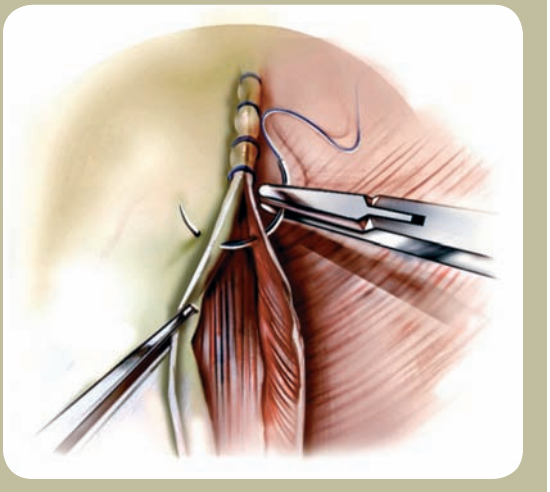
The patient's comorbidities and wound classification are used to help determine the patient's risk for SSO after ventral hernia repair.

Hernia defect



A ventral incisional hernia is illustrated with a large central fascia defect between the paired rectus abdominis muscles. (Artwork by Bill Haney provided courtesy of LifeCell.)

Fascial closure



A suture is used to close the anterior and posterior rectus sheath to provide additional support to the repair and to minimize recurrence. (Artwork by Bill Haney provided courtesy of LifeCell.)

surgeon judgment. The perioperative team must ensure that the highest level of care is applied because of the patient's increased susceptibility to SSOs.

Abdominal wall hernia is defined as the presence of a fascial defect resulting in a protrusion of the abdominal viscera. The size of these defects is variable and may range from as small as 1 cm to as large as 40 cm to 50 cm (see *Hernia defect*). One of the primary surgical tenets for success with AWR is to achieve fascial closure (see *Fascial closure*). It has been demonstrated that primary fascial closure will reduce the incidence of recurrence and SSOs.[12] Reinforcement of the repair with a surgical mesh is superior to suture repair alone.[13] The mesh provides fascial support, counteracts the forces creating the hernia, and helps to reduce recurrence.

The characteristics of the optimal mesh material have generated significant controversy over the past decade. The ideal mesh is typically characterized as promoting tissue incorporation, minimizing the incidence of SSO and SSI, is long lasting, painless, and reduces the rate of recurrence. Surgical mesh products for AWR include synthetic, biologic, and resorbable materials.[14] Synthetic materials are typically composed of polypropylene or polytetrafluoroethylene. These materials are typically used for fascial reinforcement. They are permanent, relatively inexpensive, and usually considered for patients at low risk for adverse events. Biologic materials are typically composed of human, porcine, or bovine tissues that are usually of dermal origin. These materials are usually permanent and often considered for patients at higher risk of adverse events. The rationale for biologic mesh is that it revascularizes and recellularizes into the adjacent tissues to provide long-term support. Widespread use of biologic mesh is limited because of the high cost. The newest category of surgical meshes includes the resorbable materials. These may be composed of polyglycolic acid, collagen, or silk protein. Resorbable mesh typically provides support for variable periods of time ranging from 1 to 12 months before transitioning to scar tissue.

Perhaps one of the most important aspects of hernia repair using mesh is the mesh placement's location.[15] There are various locations for mesh placement, including: the onlay technique (characterized by placement of the mesh directly on top of the fascia) (see *Onlay*); inlay technique ([interposition], characterized by mesh placement between the facial edges); underlay technique (characterized by placement on the undersurface of the anterior abdominal wall or peritoneum) (see *Underlay*); retrorectus technique (characterized by placement of the mesh between the posterior rectus sheath and the rectus abdominis muscle); and the expanded retrorectus technique (or transversus abdominis release, where

the mesh is placed between the posterior rectus sheath and the rectus abdominis and the transversus abdominis muscle).

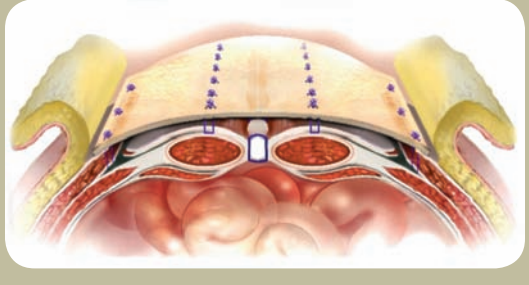
The success of these options is dependent on patient comorbidities, size of the defect, type of repair, and surgeon experience. In a systematic review evaluating the efficacy of mesh location, it was demonstrated that onlay mesh placement had fewer SSIs (4%) but had the highest recurrence (17%), seroma (12%), and explantation (5%).[15] Interposition mesh placement was associated with the highest complication rate (26%), SSI (25%), and recurrence (17%). Underlay mesh placement had the fewest complications (7%) and a low recurrence rate (7%). Retrorectus mesh placement was associated with the lowest infection (4%), seroma (3%), explantation (0.5%), and recurrence rate (5%).[15]

Other strategies that have demonstrated success with ventral hernia repair and AWR include component separation, tissue expansion, and autologous tissue flaps.[16,17] These techniques are used when the width of the midline deficit is beyond the limits of primary closure. Component separation is a technique whereby the rectus abdominis muscle is dissociated from the external oblique muscle, allowing for medial excursion (see *Component separation*). This can be performed bilaterally or unilaterally to facilitate the closure of midline defects that are up to 15 cm in width. Component separation is usually performed in conjunction with underlay mesh placement (see *Component separation and underlay*).

The use of tissue expanders can be considered in situations where component separation is not possible or the excursion of the muscle is inadequate. These devices are placed between the external and internal oblique muscles and gradually expanded with saline to stretch the overlying and underlying tissues. Once expanded, the expanders are removed, and the expanded tissues are advanced to close the defect. The final option is to use muscle or skin flaps from adjacent or remote sites. This option is usually considered in severe cases involving prior radiation therapy where the local tissue quality is damaged, inelastic, and fibrotic.

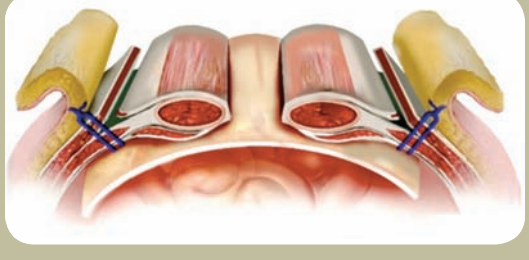
Many patients with abdominal hernias are often obese and therefore will have a moderate to large abdominal pannus.[18-20] Performing a panniculectomy either simultaneously or on a delayed basis is often beneficial for the short- and long-term success of the repair and to improve outcomes. A large pannus is often a nidus for infection and is associated with delayed healing because of the weight as well as the poor vascularity of the tissues. A panniculectomy will often reduce the likelihood of these SSOs. Panniculectomy can be performed with a variety of techniques that include a horizontal wedge excision, vertical wedge excision, and a horizontal and vertical excision known as the fleur-de-lis technique.

Onlay



The midline fascial defect is closed primarily to repair the hernia defect. A mesh material is then applied in an onlay fashion to reinforce the facial closure. (Artwork by Bill Haney provided courtesy of LifeCell.)

Underlay



In some situations, the midline fascial defect is not able to be closed primarily and an underlay mesh is placed to reinforce the hernia repair (Artwork by Bill Haney provided courtesy of LifeCell).

Outcomes

Measuring outcomes is challenging for AWR. This is primarily because there is tremendous diversity with regard to patient selection, patient comorbidities, hernia dimensions, surgical technique, prior attempts at repair, and length of follow-up. Smaller hernias are technically less challenging; however, recurrence rates are higher than expected based on long-term

follow-up. Luijendijk, in a level 1 prospective study, has demonstrated 46% recurrence rate for hernias less than 6 cm in diameter when repaired without surgical mesh and a 23% recurrence rate when repaired with surgical mesh at 3-year followup.[13] Ten-year follow-up of the same cohort of patients demonstrated an increase in the recurrence rates to 63% and 32% when repaired without and with mesh, respectively.[2]

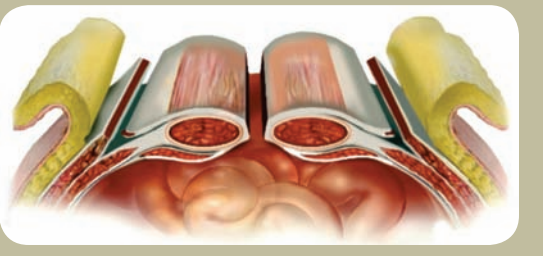
Over the past decade, surgical techniques have evolved primarily because surgeons are confronted with more complex and challenging hernias that require advanced techniques for AWR. Although surgical outcomes have moderately improved, surgeons are becoming more adept at patient selection, utilizing appropriate surgical techniques, and incorporating specific materials to assist with closure to optimize surgical outcomes. One of the current controversies with AWR where there is wound contamination or infection is whether or not to use a biologic or synthetic mesh. In a recent study evaluating biologic mesh in contaminated AWR, Garvey and colleagues have demonstrated a recurrence rate of 10.1%, a less than 30-day SSI rate of 8%, an explantation rate of 1%, and a reoperation rate of 11.2% with a mean follow up of 26 months.[21] In a similar cohort, Carbonell and colleagues, using synthetic mesh in contaminated AWR, have demonstrated a recurrence rate of 7%, a less than 30-day SSI rate of 14%, a mesh explantation rate of 4%, and a reoperation rate of 12% with a mean follow-up of 10.8 months.[22] It is generally believed that the use of biologic mesh may be advantageous for contaminated cases, whereas for clean cases, the use of a synthetic mesh placed in the proper location may be preferred based on cost considerations.

Postoperative care

The postoperative care as well as short- and long-term recovery pathways have become important aspects with regard to the well-being of the patient following AWR. The emergence of the enhanced recovery after surgery pathways has served to improve the postoperative course of these patients by reducing pain, facilitating recovery of the gastrointestinal tract, reducing morbidity, and lessening hospital stay.[23,24]

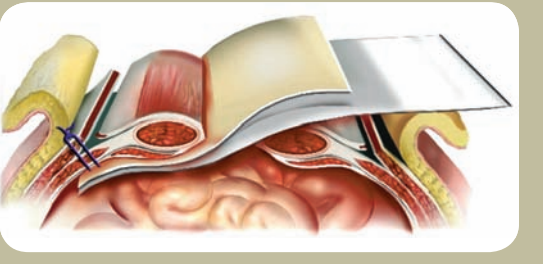
Optimizing postoperative pain has been a primary goal for nurses, surgeons, and patients.

Component separation



The component separation technique is illustrated whereby the external oblique aponeurosis is incised and undermined permitting the central rectus abdominis muscles to be advanced toward the midline. (Artwork by Bill Haney provided courtesy of LifeCell.)

Component separation and underlay



When underlay mesh is placed, it must be sutured to prevent migration. This illustration highlights the technique of component separation and underlay mesh placement. (Artwork by Bill Haney provided courtesy of LifeCell.)

Heavy opioid use tends to slow down the recovery, prolong intestinal ileus, and increase length of stay. Newer strategies have been implemented to minimize these occurrences. One of the simplest strategies is to administer I.V. acetaminophen. Acetaminophen provides good to excellent analgesic relief without restricting bowel motility and is not associated with the traditional adverse reactions of opioids, such as sedation or respiratory depression. I.V. acetaminophen has a box warning about the risk of acute liver failure and the drug is contraindicated in severe hepatic impairment or severe active liver disease.[25] Gabapentin is an analgesic and antiepileptic medication that has been demonstrated to reduce opioid use following surgery.[23] It works by attenuating the afferent sensory stimuli to diminish late postoperative pain; however, its use for this indication is off-label with regards to the FDA. Diazepam has also demonstrated success with AWR by providing antispasmodic pain relief and

muscle relaxation. Multimodal strategies for pain relief can also be considered.

The use of transversus abdominis plane (TAP) blocks has also been demonstrated to be highly effective. The transversus abdominis plane is located between the internal oblique and transversus abdominis muscles, which is where the primary innervation to the abdominal wall is located. TAP blocks will anesthetize the intercostal, subcostal, ilioinguinal, and iliohypogastric nerves. Specific agents include bupivacaine as well as the liposomal variant of bupivacaine. TAP blocks have been demonstrated to reduce postoperative pain, opioid use, and hospital length of stay.

The importance of resuming gastrointestinal motility following abdominal surgery cannot be overemphasized. Alvimopan is an opioid antagonist that has specific action on the receptors located in the gastrointestinal tract but not the centrally acting opioid receptors responsible for pain management. It has been demonstrated to reduce the duration of the postoperative ileus and reduce the incidence of postoperative nausea and vomiting. Alvimopan has a box warning about the increased incidence of myocardial infarction in patients who took the drug for long-term use; the drug is only available through a restricted program for short-term use.[26] Alvimopan is contraindicated in patients who have taken therapeutic doses of opioids for more than 7 consecutive days immediately prior to starting alvimopan.[26]

Other important postoperative measures include early enteral feeding, judicious administration of I.V. fluids, early ambulation, and nutritional supplementation.

Postoperatively, it is important for the nurse to monitor the patient for potential postoperative complications. These may include: erythema, abnormal swelling, bleeding, and incisional dehiscence. Some patients may have incisional vacuum-assisted closure devices placed to minimize the amount of edema. These devices should be cared for diligently and properly to ensure proper function. An abdominal binder or compression garment may be used to assist in reducing edema and reducing the amount of internal pressure placed on the incisional repair. Many patients will have postoperative drains to reduce the incidence of seroma. The drains typically are placed in the subcutaneous layers or along the surgical mesh. They are usually removed after 1 week of continuous suction.

The specific role of the nurse is to adequately monitor the patient, ensure that the drains are functional, the dressings are clean and dry and that the patient has adequate pain relief. It is important to encourage early ambulation to promote the return of bowel function. However, the most important role of the nurse is to educate the patient on important health aspects, such as proper nutrition and exercise. This is especially true in patients having a hernia repair because they often malnourished, obese, and have other medical co-morbidities.

Moving forward

There have been significant advancements with AWR over the past decade. Perioperative considerations have evolved such that surgeons and nurses can ensure proper pre- and postoperative care to optimize outcomes. Newer materials and improved techniques have enabled surgeons to repair many of these complex ventral hernias with greater success. There have been refinements with biologic and synthetic materials for greater reinforcement that have demonstrated success in clean and contaminated settings. Moving forward, greater collaborative efforts between surgeons and nurses (as well as among institutions) should be able to identify trends and track outcomes with greater accuracy with the ultimate goal of making AWR a more successful and predictable procedure. **OR**

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