Management of the Complicated Hernia following an Open Abdomen

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Injury/Disease Demographics

- Failure to achieve primary fascial closure following an open abdomen ranges from 24 to 34%.
- The most common reason for failure to achieve fascial closure is bowel or retroperitoneal edema. Large volume resuscitations, especially those that use large volumes of saline, place the patient at increased risk. Modern resuscitation techniques, such as damage control resuscitation, focus on limiting the use of crystalloids for resuscitation with an early focus on blood-based resuscitation. This has led to decreased rates of planned ventral hernias.[1]
- Patients with open abdomens are at increased risk of ileus (13%), anastomotic leak (7%), later fascial dehiscence (11%) and surgical site infections (19%)[1-3]
- If the abdomen is open for more than a few days, loss of domain from abdominal wall retraction becomes another potential barrier to closure.
- A skin graft over the exposed intestines is the most common coverage for the abdomen that cannot be closed.
- The first step in addressing these patients is prevention - judicious use of crystalloid in resuscitation and damage control surgery may help decrease the incidence of these complicated hernias.

Clinical Presentation

- Hernias following damage control surgery and the use of the open abdomen are complex. They are usually large (>8-10 cm) and have a meshed skin graft covering the hernia defect.
- Often, there is a concomitant stoma that the patient would like reversed at the time of surgery.
- Less often, an enterocutaneous or enteroatmospheric fistula is also present.

Acute Management of the Open Abdomen

- Acute resuscitation in critically injured patients should focus on damage control resuscitation, in which blood products are used earlier in matched ratios and unnecessary crystalloids are avoided
- Temporary closure options are chosen to protect the bowel contents, allow easy reexploration and prevent fascial retraction.[1]
    - Negative pressure dressings are commonly used. They have demonstrated utility increasing successful fascial closure rates and are not associated with increased rates of enterocutaneous fistulas.[1, 4-7]
    - Use of the Wittmann Patch has also demonstrated improved delayed fascial closure rates in some studies. Intermittent tightening of the mesh, which is secured to the patients native fascia, allows gradual closure of the defect and physiologic status allows.[8]
- Inability to achieve fascial closure will require temporizing measures as a bridge to construction of a planned ventral hernia.[9] These measures include:

    - placement of an absorbable measure to protect bowel contents and reestablish abdominal domain
    - granulation of abdominal contents with ultimate split thickness skin graft placement
    - Abdominal reconstruction after a proper period of recovery and optimization
- Average time to abdominal wall reconstruction is approximately 9 months. After abdominal wall reconstruction, outcomes tend to be similar between those with planned ventral hernias and initial fascial closure, when controlling for injury severity, age and other pertinent factors.[10]

Evaluation

- During initial history taking, an assessment of patient's symptoms, patient's risk factors, hernia complexity, and patient's goals of surgery must be elucidated.
- Hernia repair should occur within 12 months at the latest. Some evidence suggest waiting longer than 12 months increases the chances being unable to obtain primary fascial closure at hernia repair.[11]
- Patient risk factors for hernia recurrence after repair include obesity, smoking, poorly controlled concomitant medical conditions (e.g. diabetes mellitus), and nutritional status.
    - Obesity: ideal body mass index is less than 35-40 [12-14]
    - Diabetes mellitus: hemoglobin A1C should be less than 8% [15]
    - Nutritional status: serum albumin should be greater than or equal to 3.5 g/dL[16]
- Hernia complexity increases with increased size of the defect, each prior attempt at repair, and the presence of a fistula or stoma.
- The width at which the fascia cannot be re-approximated is dependent on multiple factors including abdominal wall compliance, patient size, and hernia location. Some considerations:
    - Width (generally speaking):
        - Defect <8 cm – primary fascial closure without component separation
        - Defect 8–12 cm – primary fascial closure with component separation
        - Defect >12 cm – primary fascial closure with component separation but the patient should be counselled that failure to achieve fascial closure is a possibility and a bridged repair will result in a high chance of recurrence.
    - Location: subxiphoid and suprapubic regions are most difficult to obtain primary fascial closure if defect is medium to large
    - Body mass index: obesity increases the difficulty in obtaining primary fascial closure
- On physical examination, the skin graft overlying the hernia defect should be pliable, soft and easily lifted away from the underlying bowel contents.
- Trauma patients with associated injuries, such as lower extremity or pelvic fractures, should be recovered from those injuries and independently mobile prior to hernia repair.
- Patient expectations should also be discussed prior to surgery. Often during complex abdominal wall reconstruction, there are competing interests that must be balanced and patient input is mandatory. For example:

    - When taking down an enterocutaneous fistula, should one proceed with complex hernia repair with myofascial flaps or a less successful form of hernia repair such as a large underlay or bridged repair?
    - When reversing a stoma, should one proceed with complex hernia repair with myofascial flaps or a less successful form of hernia repair such as a large underlay or bridged repair?
    - Evidence suggests synthetic mesh is superior to biologic mesh. In the setting of an enterocutaneous fistula, stoma reversal, or accidental enterotomy or colostomy, should one proceed with implantation of synthetic mesh or use biologic or native fascia?
- In these settings, surgeons must use their clinical judgement aided by a pre-operative conversation with the patient regarding goals of care.

Diagnostics/Imaging

- Preoperative labs should include serum albumin (if history and physical examination suggests a nutritional deficiency) and HgbA1C (if the patient is diabetic).
    - Serum albumin should be >3.5 g/dl
    - HgbA1C should be <8%
- A high-quality CT of the abdomen and pelvis is obtained on all patients to measure the size of the hernia defect and assess any other intra-abdominal processes that could affect the complexity of the surgery.
- As with any other stoma reversal, the distal colon is assessed for strictures by either contrast study or endoscopy.
    - In the event that a patient had a previous anastomosis and a "protective" diverting loop ileostomy or colostomy, it is vital that the anastomosis is studied and ensured not to be stenotic.

Role of Conservative Management and Associated Considerations

- High-risk patients with modifiable risk factors should have risk factors addressed prior to hernia repair.
    - This includes weight loss in the obese (BMI $\geq 40 kg/m^2$), smoking cessation, and adequate control of blood glucose in diabetics.
- High-risk patients with non-modifiable risk factors for failure should be considered for non-operative management.
- General contraindications for elective repair of these hernias include life expectancy less than 1 to 2 years, advanced cirrhosis, or severe cardiopulmonary disease.

Pre-Operative Preparation

- Patients should shower the night prior to surgery and the day of surgery.
- The evidence for bowel preparation before hernia surgery without stoma reversal or fistula is unclear.

- If a bowel prepeartion is preferred, options for patients undergoing concomitant stoma reversal include:
  - Ileostomies – self-administer two Fleet's enemas via rectum the day before surgery.
  - Colostomies – self-administer two Fleet's enemas and take an oral Nichol's prep the day before surgery (1g oral neomycin at 1400, 1500, and 2200; 1g erythromycin base or 500mg metronidazole at 1400, 1500, and 2200)[17]

Operative Techniques

- If available, neuraxial anesthesia or regional blocks should be performed prior to surgery.
- A dose of VTE chemoprophylaxis (enoxaparin or heparin) is given prior to induction of anesthesia.
- Preoperative intravenous antibiotics are given according to SCIP protocol and re-dosed accordingly throughout the duration of the surgery.
- Unless the patient has a colostomy for which lithotomy is needed to reverse, the patient is place supine.
- The abdomen is prepped and draped in standard fashion.
- The skin graft is incised longitudinally and the underlying viscera are freed from the anterior wall laterally to the paracolic gutters.
- Dissection of the underlying viscera is performed only to the extent that is needed to take down the stoma or fistula.
- The primary goal of the hernia repair is to re-approximate the midline fascia. A bridged repair has a high risk of recurrence.

Mesh Location

- Mesh can be placed in multiple different spaces:
  - *Inlay* – a bridging mesh in the event that the midline fascia cannot be approximated.
  - *Onlay* – over the anterior rectus sheath
  - *Underlay* – intraperitoneal
  - *Sublay* – in the retrorectus or preperitoneal space
- Inlay mesh placement is the least preferable location given that the rectus sheath has not been re-approximated.
- Reports regarding superiority of the other mesh positions over another are highly varied and often contain heterogeneous patient populations. However, a recent network meta-analysis of randomized controlled trials suggests that the **sublay** position resulted in the lowest recurrence and wound complication rate and is the authors' location of choice.[18]

Mesh Type

- Most evidence suggests that the addition of mesh reinforcement significantly reduces recurrence rates. When feasible, mesh should be used for these complex hernia repairs.

- In general, synthetic mesh appears superior to biologic mesh and should be used in clean cases.
- However, for complex hernia repairs where contamination is present, there is currently no high quality evidence to guide us on what kind of mesh to use.
- Equipoise between synthetic (light and mid-weight synthetic mesh) and biologic mesh exists and multiple randomized clinical trials are currently ongoing.
- In selecting the mesh type, mesh location is an important consideration without significant evidence to guide the surgeon.
    - The authors discourage the underlay placement of synthetic mesh in complex ventral hernia repairs with stoma reversal or fistula takedown.
    - However, sublay placement of synthetic mesh in these challenging situations may be preferable to sublay placement of a biologic mesh (Clinical Trials NCT02041494 and NCT03091790).

Myofascial Advancement Flaps

For defects not requiring components separation, perform primary fascial closure with sublay mesh reinforcement in the retrorectus space.

- Central scar is excised circumferentially to allow for visualization of the native fascia.
- The medial border of the rectus fascia is incised, revealing the longitudinal rectus muscle.
- This opening is extended cephalad and caudad.
- The poster rectus sheath is then mobilized off the overlying rectus muscle laterally to the border of the rectus sheath.
    - Above the arcuate line, the flap will be posterior rectus sheath.
    - Below the arcuate line, the flap will be transversalis fascia.
- The posterior rectus sheath is then closed with #1 polygalactin 910 in a running fashion.
- Mesh is then placed within the rectus sheath, posterior to the rectus muscle and secured with minimal transfascial sutures.
- The anterior rectus sheath is then closed with #1 polydioxanone in a running fashion.

For smaller defects that require myofascial advancement flaps for primary fascial closure, perform posterior components separation with sublay mesh reinforcement in the preperitoneal space.

- The posterior component separation has the benefit of avoiding skin flaps, which reduces wound complications, but is technically challenging if not experienced with the procedure.
- After developing the retrorectus space described above and before closure of the posterior rectus sheath, the posterior rectus fascia is incised medial to the perforating nerves and arteries supplying the rectus muscle.
- This allows entry into the space between the transversalis fascia and transversus abdominus muscle.
- This preperitoneal/pretransversalis space is then developed to allow for mesh placement.

- The posterior rectus sheath is then closed with 1 polygalactin 910 in a running fashion.
- The selected mesh is placed in the developed space and secured with minimal transfascial sutures.
- The anterior rectus sheath is then closed with 1 polydioxanone in a running fashion.

For larger defects that require myofascial advancement flaps for primary fascial closure, perform anterior components separation with sublay mesh reinforcement in the retrorectus space.

- The anterior component separation requires access to the external oblique lateral to the semilunar line. The advancement flap can be performed in an open fashion with large skin flaps, an endoscopic manner with minimally-invasive techniques, or small medial incisions to spare the perforating arteries that feed the overlying subcutaneous tissues.
- After developing the retrorectus space described above and before closure of the posterior rectus sheath, the external oblique is incised 1 cm lateral to the semilunar line.
- This allows entry into the plane between the external and internal obliques.
- This plane is developed cephalad over the rib cage, caudad below then anterior superior iliac spine, and laterally as far as possible.
- The posterior rectus sheath is then closed with #1 polygalactin 910 in a running fashion.
- Mesh is then placed within the rectus sheath, posterior to the rectus muscle and secured with minimal transfascial sutures.
- The anterior rectus sheath is then closed with #1 polydioxanone in a running fashion.

Stoma Reversal

- Patients undergoing complex ventral incisional hernia repairs who have a concomitant stoma or fistula can present a challenging case.
- The stoma is sewn closed prior to prepping the abdomen to minimize spillage.
- In general, performing stoma reversal or fistula take down and ventral incisional hernia repair at the same operation is ideal.
- If reversing a fistula in a patient dependent on parenteral nutrition, the restoration of intestinal continuity take precedent over hernia repair. This should be discussed with the patient preoperatively.

Drain Placement

- Drains are typically reserved for large subcutaneous skin flaps and in the setting of biologic mesh implantation, which can result in a large seroma.
- Minimally invasive subcutaneous skin flaps and synthetic mesh placed in the underlay or sublay position do not typically need drains.

Post-Operative Management

- Multi-modal pain strategies to minimize opioid use are instituted post-operatively, including regional anesthetic, if available.
- Drains are maintained to bulb suction until output has decreased significantly to warrant removal.

Complications

- Wound complications increase in incidence with patient risk factors and the presence of skin flaps.
- Seromas should be left undrained in the absence of infection.
- Skin necrosis may require debridement or local wound care.
- Superficial surgical site infections are opened and packed.
- Deep (for sublay mesh) and organ/space (for underlay mesh) surgical site infections present a serious problem in the setting of mesh implantation.
    - Light and mid-density synthetic meshes can be sometimes be cleared of infection with drainage of any fluid collections and extended antimicrobial therapy.
    - Biologic mesh typically can also be treated with drainage and antimicrobial therapy.
    - When these interventions fail, mesh explanation can remove the nidus of infection.

Considerations for Special Populations

- Patients with a complete loss of domain are particularly problematic. In some hernias, not only is fascial closure impossible but skin closure after creation of skin flaps is not possible. In these situations, it is ideal to have a multidisciplinary approach with a plastic surgeon for possible preoperative tissue expanders or progressive pneumoperitoneum or flap coverage of a bridged hernia repair.

Proposed Reading List:

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