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## Temporary Abdominal Closure Techniques

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## Continuing Education Activity

Several techniques have been described to manage the open abdomen after a damage control laparotomy. Primary fascial closure remains the gold standard, and the goals of any management strategy should be to protect the bowel and minimize lateral retraction of the fascia. This activity reviews the types of temporary abdominal closure and highlights the importance of active strategies in managing the open abdomen.

### Objectives:

- Describe and compare the techniques available for temporary abdominal closure.
- Outline strategies to facilitate fascial closure.
- Review common complications of the open abdomen.
- Explain the role of the surgeon in coordinating with the interprofessional team regarding fluid management, nutrition, and sedation goals to improve outcomes.

Earn continuing education credits (CME/CE) on this topic.

## Introduction

Critically ill patients with underlying intraabdominal hypertension due to sepsis or injury are often managed with a damage control laparotomy (DCL), which involves the minimum intervention necessary to save the patient's life. In order to save time, the abdomen may be left open to facilitate a second look to confirm the control of bleeding or sepsis before fascial closure. In the interim, some patients will develop bowel and abdominal wall edema with a high-volume resuscitation, especially if the crystalloid fluid is used primarily.

The many causes and management of intraabdominal hypertension as well as the indications for a damage control laparotomy are discussed in other topics. Here we focus on the temporary techniques that are used to hold the abdomen together, ways to facilitate eventual fascial closure, and the complications of these techniques. Other topics will describe the eventual reconstruction of the abdominal wall when the fascia cannot be closed.

## Anatomy and Physiology

In the setting of an emergency laparotomy with an unstable patient, the surgeon may decide to temporarily close the abdomen to facilitate the resuscitation of the patient. The anatomy most relevant to temporary closure includes the following layers of the midline abdominal wall:

- Skin
- Subcutaneous tissue

- Superficial fascia
- The linea alba or midline of the rectus sheath (aponeuroses of the external oblique, internal oblique)
- Transversalis fascia
- Preperitoneal space
- Peritoneum

A key concept in temporary abdominal closure is to prevent the lateral retraction of the oblique musculature to preserve the ability to re-approximate the linea alba.

## Indications

The most important indication for leaving the abdomen open is the patient who is continuing to decline during the stress of the operation. The decline could be indicated by increasing lactate, which is indicative of worsening shock, increasing acidosis or coagulopathy, or an ongoing transfusion or vasopressor requirement. Once bleeding and contamination are controlled (damage control), the decision must be made whether the patient will be able to tolerate further operative intervention and communicated to the rest of the team urgently.

Occasionally, a patient may have too much edema or intraabdominal hypertension, which precludes fascial closure. In the slightly more stable patient, the surgeon may desire a “second-look” operation to remove the surgical packing used to achieve hemostasis, confirm the viability of intraabdominal organs, or to perform a bowel anastomoses under better conditions. The surgeon should exercise caution in prescribing the need for a second-look operation, as the best opportunity for primary fascial closure is at the index operation prior to the unopposed force of the lateral abdominal wall muscular retraction.

## Contraindications

The best outcome for the patient is the primary fascial closure at the earliest opportunity. Thus, the most significant contraindication to temporary abdominal closure occurs when the patient is to have the abdominal cavity closed and have the indicated operation completed in its entirety.

## Equipment

At the end of the laparotomy in the operating room, while the patient is under general anesthesia with full relaxation of the abdominal wall via neuromuscular blockade, the chosen technique described below can be performed to achieve static or dynamic support of the abdominal wall.

## Personnel

The operating surgeon will need at least one assistant to provide traction or gentle approximation of surrounding tissues in most of the techniques described below. Even in the case of negative pressure wound therapy, the assistant can help reapproximate fascial edges with a smaller surface sponge to prevent further lateral retraction. No additional patient preparation is required for temporary abdominal closure.

## Technique

### Management Options

Primary fascial closure remains the gold standard in the closure of the open abdomen, but it is only achieved in some patients. Surgeons prioritize wound coverage with either a Bogota bag or temporary, rapidly absorbable mesh (e.g., Vicryl) with plans for expected hernia formation and delayed complex abdominal wall reconstruction. Alternative strategies all focus on one primary goal that is to provide tension across the fascia so that it does not shrink or retract. This phenomenon is commonly referred to as loss of domain, caused by the forces from the lateral abdominal wall musculature now unopposed. Ideally, a temporary dressing will also protect the abdominal contents, minimize the

chance of fistula formation, remove excess fluid, and provide strength to the abdominal wall in between trips to the operating room. Most recent evidence favors the trend toward dynamic therapy that allows for sequential tightening of the abdominal wall in between trips to the operating room.

### Static Therapies

**Sequential primary closure:** Incisions made for DCL often extend from the xiphoid to the pubis. During each return to the operating room, consider whether the fascia can be closed, or at least partially closed, from the cranial and/or caudad direction using a slowly absorbable suture.

**Negative pressure wound therapy (NPWT):** A vacuum-assisted dressing consists of a bowel protection layer, a soft spongy material, followed by an adhesive bandage with a small opening for a drain connected to continuous suction in the simplest form. There are many industry versions of this dressing, which has been well described for the last two decades. The technique remains preferable to simple silastic dressings such as the Bogota bag to achieve fascial closure.[1] One distinct advantage of this vacuum device is the newer ability to allow for irrigation, which has been suggested to help clear inflammatory cytokines in treating a septic cause for the open abdomen.[2][3] Best results are achieved when attempts are made to approximate the fascia as much as possible spatially or with one of the dynamic therapies below to minimize lateral muscle traction.

**Mesh bridging:** As mentioned above, using a rapidly absorbable, biologic, or synthetic mesh placed as an interposition graft between the fascial edges has been described in the literature. In the setting of massive loss of domain, it may be the only technique to facilitate coverage of the intestines and facilitate granulation to allow skin grafting and later reconstruction.[4][5]

### Dynamic Therapies

**Mesh-mediated fascial traction (MMFT):** In this technique, the mesh is sewn to the opposing fascial edges and sequentially tightens the anterior abdominal wall.[6] The most commonly known commercial version is called the Wittman patch. Various mesh has also been sewn in an underlay fashion,[7][8] as well as an overlay on top of the fascia.[9] Additional benefits may come from combining this therapy with a fluid removal system such as that provided by the vacuum-based dressing.

**Dynamic retention sutures or abdominal reapproximation anchor (ABRA):** Plastic tubes are inserted through the abdominal wall away from the fascial edge and held in place with an adhesive button. This placement of a temporary retention suture that could sequentially tighten the abdominal wall to minimize loss of domain in the open abdomen was first described more than 20 years ago.[10] The advantage is that it provides fascial tension while preserving the fascial edge for delayed primary closure.

Randomized controlled studies have demonstrated that either dynamic therapy with NPWT is better for fascial closure than just NPWT alone.[11] The studies comparing the different dynamic techniques are mostly retrospective observational studies. Most recently, a meta-analysis using observational cohort studies demonstrated 93% fascial closure with NPWT+ABRA versus 72% NPWT+MMFT.[12]

### Facilitation of Fascial Closure

**Hypertonic Saline (HTS) resuscitation:** A protocol developed using hypertonic saline for resuscitation and NPWT has had improved success in early fascial closure in DCL patients.[13][14]

**Botulinum toxin A (BTA):** BTA has been used as a method of chemical paralysis of the strong opposing forces of the lateral abdominal wall musculature used in complex abdominal wall reconstruction. One study by Zielinski et al. described the use of this technique in the open abdomen to facilitate primary fascial closure.[15][16]

### Complications

**Enteratmospheric fistula (EAF):** Every surgeon fears the development of an EAF due to the open abdomen. These fistulas are notoriously challenging to manage, as the enteric succus drains throughout the wound bed to make wound

healing quite challenging. The fistula output may be thin with high biliopancreatic content if proximally located, or thick, brown, and highly contaminated with the gut microbiome if located distally. Each type of fistula output presents its challenges. The management of fistulas are discussed in detail elsewhere, but there are a couple of key points for the open abdomen.

A common misconception is that NPWT is associated with fistula formation when, in fact, EAF is lower in NPWT than other abdominal packing strategies.[11] Modern NPWT dressings can be modified to protect the bowel with the addition of proprietary sponges or Vaseline-impregnated gauze. Isolation of the enteric contents will allow for nearby wound healing. The best situation is where the output can be managed with a pouch-like wound management device or temporary catheter mixed with vacuum-based dressing to allow the surrounding skin and wound to heal. For skin irritation due to bile salts in proximal fistulas, consider cholestyramine mixed with antifungal cream applied topically.

As is true for all fistulas, nutrition is critical. Enteral nutrition is ideal if the fistula output remains low and manageable, but early support with parenteral nutrition may be necessary to avoid a catabolic state. Nutrition is even more critical in already malnourished patients.

Hernia: Early closure within 10 to 14 days is the easiest way to prevent hernia. Few studies follow the long term development of hernias after an open abdomen, but the incidence has been reported as high as 21% at two years and >50% at five years.[17] It remains controversial whether component separation techniques should be used in the open abdomen to achieve fascial closure initially, as hernias still develop ~20% of the time, and now the fascial planes are distorted for more complex abdominal wall reconstruction later.

## Clinical Significance

- TAC should include some method to minimize lateral abdominal wall retraction force.
- Think early and often about primary fascial closure and consider at every operative intervention, ideally within 10 to 14 days.
- The highest rate of fascial closure occurs with dynamic therapy combined with negative pressure wound therapy.
- Manage fluids carefully to facilitate fascial closure.
- Nutritional optimization is critical to allow for proper wound healing, including the ability to heal fascia.
- If enteroatmospheric fistula develops, isolate the enteric contents away from the rest of the wound.

## Enhancing Healthcare Team Outcomes

The acute care surgeon needs to coordinate care with the intensive care team involved in the resuscitation of these critically ill patients to identify changing fluid goals to achieve fascial closure. Soon after resuscitation is complete, active fluid management must become the prime focus of all concerned. Many patients are kept intubated with an open abdomen, but sedation can be weaned to maintain a Richmond agitation sedation score (RASS) of 0, a calm state, especially with the common use of NPWT. This helps to minimize fluid from sedation infusions, and it will help the rehabilitation of the patient once fascial closure is achieved. Lastly, since the bowel may be in discontinuity, it is absolutely critical that the surgeon evaluates the patient's baseline nutritional status and discusses with the team a strategy using enteral or parenteral nutrition to aid in wound healing.

## Continuing Education / Review Questions

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