Management of the Open Abdomen—Usefulness of the bilateral anterior rectus abdominis sheath turnover flap method for early fascial closure

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The development of the concept of damage control and improved understanding of the pathophysiology of abdominal compartment syndrome have been great advances in both trauma care1–3 and nontraumatic surgical conditions.4 However, these approaches require open abdominal management for a considerable period. We developed the anterior rectus abdominis sheath turnover flap method for early fascial closure in patients requiring open abdominal management who cannot undergo standard abdominal wall closure.5 To the best of the authors’ knowledge, this is the first report of this method being used as a technique for abdominal wall reconstruction in the early stages. The method may reduce the need for planned ventral hernia, in which the abdominal contents are covered with only a skin graft and abdominal wall reconstruction is required at a later date.

What Are Damage Control and Abdominal Compartment Syndrome?

In conventional trauma care, definitive control and repair of all injuries is accomplished in the immediate postinjury setting. However, the physiologic derangement of the massive shock state often leads to a fully repaired but dead patient. In response to these catastrophic challenges, the concept of “damage control” has arisen as a treatment merely to control but not definitively repair injuries. Although control of hemorrhage and contamination is mandatory, the time required for performing formal surgical procedures may aggravate the vicious cycle of coagulopathy, acidosis and hypothermia.1–3

The practice of damage control includes three separate components: 1) abbreviated resuscitative surgery for rapid control of hemorrhage and contamination, as well as for temporary abdominal wall closure; 2) ongoing core rewarming, correction of coagulopathy and hemodynamic optimization in the ICU; and 3) reexploration for definitive injury management and abdominal wall closure.1–3 However, prolonged open abdominal management is required if visceral edema continues for more than several days after damage control surgery.

Abdominal compartment syndrome (ACS) is an increasingly recognized clinical entity which occurs when intra-abdominal pressure is abnormally high in association with organ dysfunction. Although the most common cause of ACS is blunt abdominal trauma associated with massive hemorrhage, ACS can also occur in cases of burns and other non-traumatic conditions such as complex major abdominal surgery and severe acute pancreatitis requiring massive fluid resuscitation.4,6,7 When a sustained increase in intraabdominal pressure is observed despite medical management (i.e. sedation, neuromuscular blockade, evacuation of abdominal fluid collection), decompressive laparotomy is required to treat the increased intraabdominal pressure and improve abdominal visceral perfusion and systemic cardiovascular/respiratory derangement.7 However, this abdominal decompression procedure leaves the abdomen open.
Conventional Approach to Open Abdomen

In typical management scenarios for patients requiring open abdominal management who cannot undergo early standard fascial closure, many patients require prolonged open abdomen because of visceral edema. During this interval, the musculofascial structure of the abdominal wall contracts laterally, leaving patients with a large midline defect where standard fascial closure is not possible. Many patients have a large ventral hernia for a period during which the granulated abdominal contents are covered with only a skin graft, requiring subsequent complex abdominal wall reconstruction. To reduce the need for an intermediate period with a large ventral hernia that requires abdominal wall reconstruction at a later date, several techniques such as vacuum-assisted wound closure and application of a Wittmann patch have been employed as methods of achieving temporary abdominal wall closure.9–11

Risk of Enterocutaneous Fistula

Enterocutaneous fistula formation is a devastating complication of open abdomen and has been reported to occur in 5% to 25% of cases.10,12–14 Although lower fistula rates have been reported using vacuum-assisted wound closure, patients requiring prolonged mesh application have high risk of enterocutaneous fistula. The risk of enterocutaneous fistula may increase as the duration of open abdominal management is prolonged.12 Moreover, the development of 3 of 14 fistulae after skin grafting of the granulated open wound has been reported,10 suggesting the importance of early definitive wound closure to prevent fistula formation.

Reconstruction of Abdominal Wall after Planned Ventral Hernia

Several methods have been proposed to accomplish late reconstruction of the abdominal wall for patients after a period with a planned ventral hernia following open abdominal management, such as component separation,16 rectus turnover flap,17 and modified component separation techniques.12 Although use of the “open-book” varia-

Application of the Bilateral Anterior Rectus Abdominis Sheath Turnover Flap Method for Early Fascial Closure and Prevention of Enterocutaneous Fistula

Management of open abdomen

In our institution, patients who required temporary abdominal wall closure underwent either Bogota bag closure (suturing of a sterile opened intravenous fluid bag to the skin edges) or a vacuum pack closure using the modified method described by Garner et al.9 Recently, the latter...
has been the preferred technique in all cases except for initial damage control surgery where aggressive resuscitation is ongoing and visceral edema therefore may increase after surgery. Dressings were changed every 48 to 72 hr until fascial closure or the decision was made to perform skin grafting over an intentional ventral hernia. If the abdominal fascia could be fully approximated under no tension, standard fascial closure was performed. After 10 to 14 days following initial laparotomy, use of a turnover flap constructed from the anterior rectus abdominis sheath was considered instead if the distance to be closed with fascia was less than 15 cm in patients unsuitable for standard fascial closure because of prolonged visceral edema. Formation of a planned ventral hernia using a skin graft over granulated abdominal contents was chosen in patients without edema resolution 3 weeks or more after the initial laparotomy who were not candidates for either method of fascial closure.

**Surgical procedure for the anterior rectus abdominis sheath turnover flap method**

The procedure is begun by separating the skin and underlying adipose tissue from the anterior rectus sheath to create a flap. Next, creation of a turnover flap from the anterior sheath is begun by incising the anterior sheath along the entire length of its lateral border. The anterior sheath then is dissected from lateral to medial, freeing it from the rectus muscle. Kept intact, the linea alba serves as a medial hinge to mobilize the flap (Fig. 1). The fascial flap is then reflected medially with care so as not to damage the anterior sheath.

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**Fig. 2-1 Intraoperative view of the anterior rectus abdominis sheath turnover flap method (initial steps)**

A: View just after vacuum packing removal (11th day of open abdomen). B: First, skin and underlying adipose tissue are separated from the anterior rectus sheath to create a flap. C: Skin and adipose tissue is completely dissected from the anterior sheath bilaterally beyond the lateral border of the rectus sheath. D: The anterior rectus sheath flap is reflected medially by dissection from lateral to medial, freeing it from the rectus muscle. The linea alba is kept intact as a medial hinge (from reference 5).
After creating bilateral turnover flaps, we approximate the flaps to cover the abdominal contents using interrupted sutures. Thereafter, the skin and underlying adipose tissue are approximated (Figs. 2 and 3).

**Results of our approach for open abdominal management**

Fifty-four patients (21 trauma, 33 non-trauma patients) who required open abdominal manage-
ment between April 1997 and August 2007 were treated. Patients with an acute abdominal wall defect arising from necrotizing fascial infection, or who died despite resuscitation within 48 hr of open abdominal management were excluded. Most patients had developed massive intestinal edema with coagulopathy secondary to large volumes of fluid resuscitation, precluding primary abdominal closure without undue tension after the initial laparotomy.

The mean duration of open abdomen was 13.9 ± 21.2 days for all study patients. Of 33 nontrauma patients, 15 survived, as did 12 of the 21 trauma patients. In nontrauma patients, the time from initial laparotomy to standard fascial closure was 1 to 5 days in 8 patients; to turnover flap closure was 1 to 31 days in 10 patients; and to skin grafting over a ventral hernia was 49 to 69 days in 3 patients. In trauma patients, the time to standard fascial closure was 1 to 5 days in 8 patients; to turnover flap closure, 6 and 30 days in 2 patients; and to skin grafting, 78 to 89 days in 3 patients. During the study period, no enterocutaneous fistulae or abdominal abscesses occurred.

Fistulae and complications in patients treated with a turnover flap constructed from the anterior rectus abdominis sheath

No fistulae developed in 12 patients. Wound infection developed in 4 patients, with 1 infection being major. In that patient, the midline skin closure dehisced, but the approximated fascial flap remained intact. The skin was closed secondarily.
Although midabdominal bulging was observed in more than half of patients who underwent anterior rectus abdominis sheath turnover flap closure, no abdominal wall hernia requiring secondary reconstruction developed up to 80 months after the procedure.

In many patients requiring conventional open abdominal management, the granulated abdominal contents are covered only with a skin graft, which carries with it the risk of enterocutaneous fistula. These patients ultimately require complex abdominal wall reconstruction at a later date. Early abdominal wall reconstruction in noncandidates for standard abdominal wall closure has received little attention. Early fascial closure using the anterior rectus abdominis sheath turnover flap may reduce the need for skin grafting and subsequent reconstruction. This approach can be considered as an alternative technique for the early management of patients with open abdomen.

References