Modified triple-layer peritoneal-aponeurotic transposition: A new strategy to close the ''open abdomen''

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Intentionally leaving the abdomen open after a laparotomy was used intermittently for several decades.[1,2] More recently, the widespread use of staged laparotomy in damage-control surgery has made the "open abdomen" a standard part of the trauma/acute care surgeon's armamentarium. General indications for the open abdomen after completing a laparotomy can be grouped into three categories, namely, anatomic, logistic, and physiologic.[3] Anatomic indications are frequently seen in patients who have an unbridgeable abdominal wall and impending risk of abdominal compartment syndrome. A less frequent cause is trauma-induced injuries to the abdominal wall, which produce massive tissue loss. A logistic indication for the open abdomen allows easy access for serial surgical interventions while preserving the fascia. In the physiologic indication category, severe systemic derangement requires damage-control/bailout strategies.[4]

Management of the open abdomen involves temporary abdominal closure to protect the underlying fascia and viscera, decrease fluid losses, and prevent loss of abdominal domain if possible.[5] Advancements in temporary abdominal closure techniques have increased definitive closure rates significantly.[6–8] Nevertheless, patients with open abdomens still incur serious complications including enteroatmospheric fistulas, fascial retraction with loss of abdominal domain, and massive incisional hernias.[3,9] Moreover, physical and social functioning are significantly worse in patients discharged with a chronic incisional hernia compared with patients discharged with primary fascial closure.[10]

A recent systematic review and meta-analysis involving more than 3,000 patients with open abdomens showed that the average primary fascial closure rate was 62%.[11] The results, after adjusting for heterogeneity, indicated that primary fascial closure had a significant role in mortality reduction.[11] Furthermore, primary closure also resulted in fewer complications and shorter hospital stay.[3,11] Considering that the mean time to primary closure in open abdomens ranges from 2.2 days to 14.6 days, there is only a small window of opportunity for success.[11] If that brief period is missed, patients will likely require repair of difficult ventral/incisional hernias. Primary suture repair is rarely possible in those types of hernias, with recurrence rates in excess of 50% in long-term follow-up.[12] Despite various techniques for repair of incisional ventral hernias and significant improvement in mesh construction, surgical correction of this condition remains a challenge.[13,14]

The Lázaro da Silva technique, also known as longitudinal peritoneal-aponeurotic transposition, uses the fibroperitoneal tissue of the hernia sac and the rectus sheath to create three overlapping layers for incisional hernia repair. The hernia sac is opened in the midline, followed by two longitudinal incisions in the rectus sheath, one in the anterior sheath and the other in the posterior sheath on the contralateral side.[15,16] Consequently, the medial edges of the rectus abdominis muscles advance toward the midline, and tension in the suture line is reduced despite reconstruction of the linea alba by the layers that overlap in different planes. Previous reports showed low recurrence rates with this procedure and with a variation using a single mesh placed as an underlay.[15–18]

Given the large size of abdominal wall defects in "open abdomens" and the absence of a fibroperitoneal hernia sac, definitive closure of those defects frequently involves separation of the abdominal wall layers, release of myofascial planes, and the use of mesh.[12,19] In this study, we describe a new strategy for definitive closure of the open abdomen, which follows the same principles of the triple-layer peritoneal-aponeurotic transposition conceived by Lázaro da Silva for incisional hernia repair except for the use of two meshes as replacement for the hernia sac.

TECHNIQUE

Patients should undergo appropriate preoperative assessment, a Foley catheter is placed, and antibiotic prophylaxis is given. With the use of electrocautery, the skin and subcutaneous tissue are separated from the anterior surface of the rectus sheath starting at the borders of the laparotomy and extending just beyond the lateral borders of the rectus muscles (linea semilunaris), completely exposing the anterior sheath bilaterally. Any large vessel encountered during that dissection should be ligated with absorbable suture. Next, careful adhesiolysis is performed between intra-abdominal contents and the anterolateral abdominal wall bilaterally, from the xiphoid process to the pelvis. Subsequently, a longitudinal incision, slightly curvilinear toward the midline, is performed in the anterior rectus sheath on one side within 1 cm to 2 cm from the medial border using electrocautery. Then, a similar incision is made in the posterior rectus sheath on the opposite side. The incisions span the entire length of the rectus abdominis muscles. In our practice, we generally select the side with fewer adhesions to incise the posterior rectus sheath, with the incision extending

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This work was presented in part at the Trauma Association of Canada Annual Scientific Meeting–Trauma 2015, in Calgary, Alberta, Canada.

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DOI: 10.1097/TA.0000000000000817

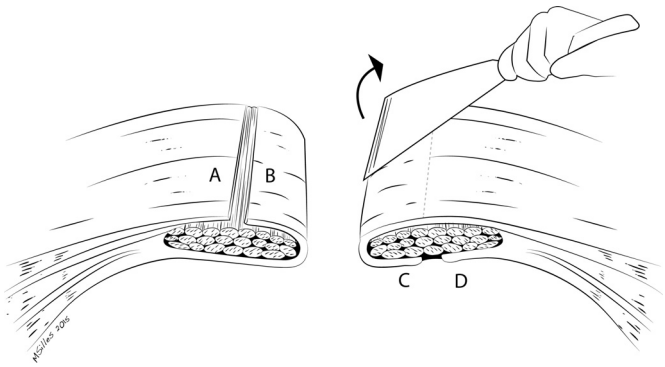

Figure 1. A longitudinal incision spanning the entire length of the rectus abdominis muscle is made in the anterior rectus sheath approximately 2 cm from the medial margin. A similar incision is made in the posterior rectus sheath on the opposite side. In total, four free edges are created, two lateral (A and D) and two medial (B and C).

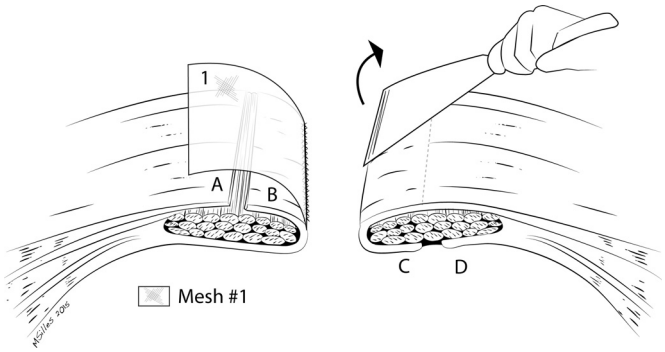

Figure 2. Mesh #1 is sutured along the border of the laparotomy on the same side where the anterior fascia was incised.

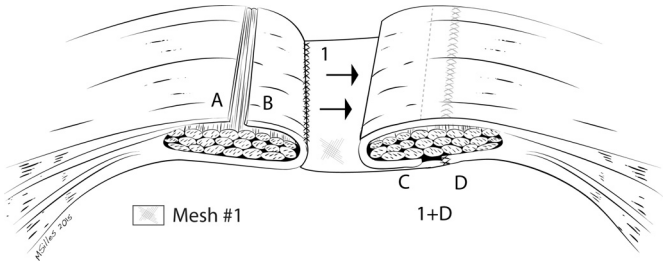

Figure 3. The free edge of Mesh #1 is sutured to the lateral border of the incision created in the posterior rectus sheath (D). The antiadhesive coating of that mesh should be facing the abdominal cavity.

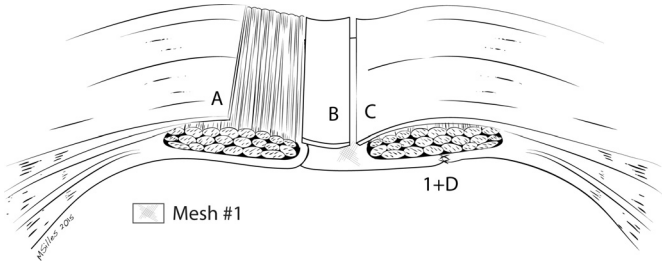

Figure 4. The medial border of the incision created in the anterior rectus sheath (B) is released and everted, partially exposing the anterior surface rectus abdominis muscle on that side. On the other side, the medial border of the posterior rectus sheath (C) in conjunction with the aponeurosis of the transversus abdominis muscle, below the arcuate line, are mobilized from the posterior surface of the rectus abdominis muscle.

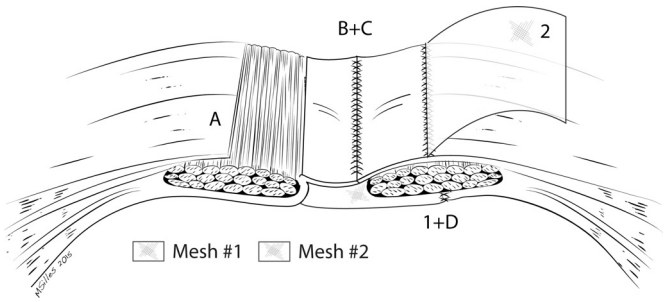

Figure 5. The two flaps (B and C) are advanced medially and sutured together at the midline. Mesh #2 is sutured to the intact anterior rectus sheath overlapping at least 5 cm from the midline.

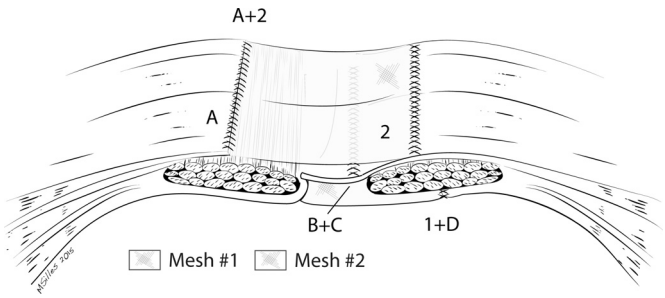

Figure 6. The free edge of Mesh #2 is sutured to the lateral border (A) of the incision created in the anterior rectus sheath.

below the arcuate line (linea semicircularis). Care must be taken to avoid injury of the inferior epigastric vessels in that location. A total of four free edges (two medial and two lateral) are created in the rectus sheaths (Fig. 1). At this point, a large synthetic mesh measuring at least 30 × 30 cm with an antiadhesive coating facing the abdominal cavity is sutured (running nonabsorbable monofilament suture) along the border of the laparotomy on the contralateral side of the incision performed on the posterior rectus sheath (mesh #1) (Fig. 2). An absorbable mesh (Vicryl) can also be used. Next, working from cranial to caudal, the free edge of the same mesh (mesh #1) is sutured to the lateral border of the incision created in the posterior rectus sheath on the contralateral side (Fig. 3). After completion, this layer will preclude access to the abdominal cavity. Therefore, sponges, sharps, and instrument counts are recommended before commencing the suture. The next step involves the release followed by eversion of the medial border of the incision created in the anterior rectus sheath exposing the rectus abdominis muscle. Similarly, on the contralateral side, the medial border of the posterior rectus sheath and the aponeurosis of the transversus abdominis muscle, below the arcuate line, are mobilized from the posterior surface of the rectus abdominis muscle (Fig. 4). The flaps obtained with the previous dissection are advanced medially and sutured together at the midline using multiple figure-of-eight stitches of nonabsorbable 0 monofilament suture (Fig. 5). Afterward, a large nonabsorbable synthetic mesh (mesh #2), with or without antiadhesive coating measuring at least 30 × 30 cm, is sutured to the uncut anterior rectus sheath using multiple figure-of-eight stitches of nonabsorbable 0 monofilament suture ensuring overlap of at least 5 cm from the midline (Fig. 5). Finally, the free edge of mesh #2 is sutured to the lateral border of the incision created in the anterior rectus sheath using multiple figure-of-eight stitches or running nonabsorbable 0 monofilament suture (Fig. 6). The subcutaneous tissue is closed in layers over two closed suction drains placed above the mesh. In the presence of a massive abdominal wall defect and excessive intra-abdominal distension, one may be forced to forgo the second layer of the procedure depicted in Figure 5, increasing the chances of an incisional hernia.

Currently, this technique has been used in 13 patients with open abdomens for trauma/acute care surgery deemed not candidates for primary fascial closure.[3] The distance between the fascial edges measured intraoperatively at the midportion of the abdomen was on average 11.6 cm. After a follow-up period

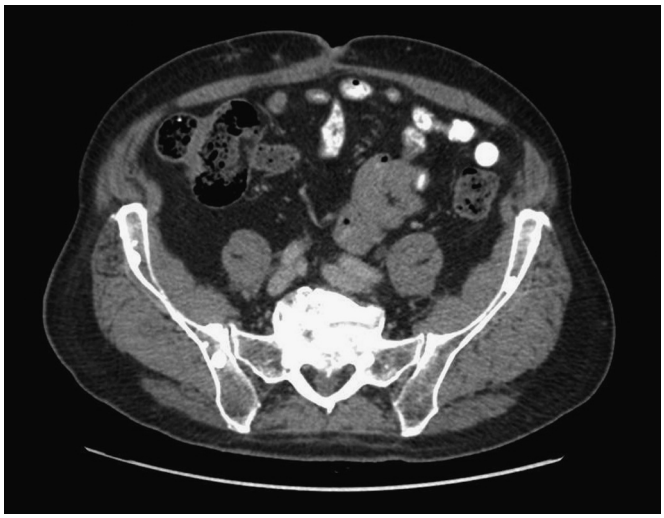

Figure 7. CT scan of the abdomen performed 6 months after the procedure shows medialization of the rectus abdominis muscles and no defect in the abdominal wall.

of 36 months, 12 patients did not have detectable hernias on physical examination. One patient has no evidence of a hernia on computed tomographic (CT) scan of the abdomen 6 months after surgery (Fig. 7). The most common complications were surgical site infection (n = 2) and seroma (n = 4), all of which were managed conservatively. There were no cases of abdominal compartment syndrome or enteric fistula associated with the new technique.

The two most interesting findings in patients who had abdominal CT scans performed after undergoing the procedure were the reconstitution of the linea alba and shift of rectus abdominis muscles toward the midline (Fig. 7).

In summary, the new technique described herein is a suitable option for primary closure of the open abdomen in the trauma and acute care surgery setting. The method creates three overlapping layers over the abdominal cavity, which results in the medialization of the rectus abdominis muscles.

AUTHORSHIP

J.B.R.N. devised the technique and performed all surgical procedures, data collection, data interpretation, elaboration of the manuscript, and critical revision. F.A.A. contributed in the literature search, writing, and critical revision. S.B.R. contributed in the critical analysis of the technique, writing, and critical revision. O.D.R. contributed in the critical analysis of the technique, writing, and critical revision.

ACKNOWLEDGMENT

We thank Mr. Marcelo Silles for drawing the figures.

DISCLOSURE

The authors declare no conflicts of interest.

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