Abdominal Wall Reconstruction with Mesh and Components Separation

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Abstract

Incisional hernias in the abdominal wall are a by-product of multiple previous laparotomies. Unfortunately, the incidence of incisional hernias has risen, as we have progressed with new surgical techniques in the treatment of abdominal pathologies. Many methods have been attempted in the past to achieve a better and more durable repair, namely using components separation to bring the fascia into the midline, and reinforce incisional hernias with different mesh materials. The authors review the recent literature regarding the efficacy of these synthetic materials and biomaterials in incisional hernia repair, as well as share their experience in treating complex abdominal wall defects using components separation and biologic mesh.

Keywords

- components separation
- biologic mesh
- ventral hernia

Complex abdominal defects present a challenge to any reconstructive surgeon. Although the development of new laparoscopic equipment and techniques have led to a decrease in open laparotomies, this change is offset by an increase in the aggressiveness of surgeons to operate on intraabdominal pathologies (oncologic, traumatic, and infectious) that were deemed inoperable in the past. Incisional hernia, the by-product of these operations, is estimated to occur in up to 11% of all laparotomies.[1–3] In the United States, more than 250,000 surgical procedures are performed every year to treat this medical condition.

Evolution of Prosthetic Implants

Given the extensiveness of this problem, continuous efforts have been made to improve the outcome of ventral hernia repairs. Although primary fascial apposition may be appropriate in smaller defects ($<$ 4 cm in width), the recurrence rate following primary repair is estimated to be in excess of 50%.[1,4] Prosthetic implants have significantly improved the results of primary fascial closure by minimizing tension on the repair site. Due to this advantage, synthetic biomaterials, such as polypropylene (Prolene®; Ethicon, Somerville, NJ) and expanded polytetrafluoroethylene (ePTFE, or Gore-Tex® most commonly; W.L. Gore & Associates, Inc., Elkton, MD), have become the mainstay of ventral hernia repair.[5–9] The macroporous structure of polypropylene allows for fibrous ingrowth and mesh incorporation into the abdominal wall, thereby providing a strong repair. It is, however, associated with adhesions to intraabdominal viscera and enterocutaneous fistula formation.[10–12] Even though ePTFE and ePTFE/macroporous mesh composite patches are strong, biocompatible, and less likely to adhere to the viscera, they do not perform well in the presence of contamination, infection, and enteric fistula.[13,14] After analyzing the results of a prospective randomized controlled trial, Luijendijk reported that nearly one quarter of ventral hernias repaired with synthetic mesh recur within 3 years, and this recurrence risk increases with each additional operation.[15]

This fact is illustrated by the results of a retrospective cohort study of a population-based hospital discharge database which showed that 12% of patients undergoing incisional hernia repair required at least one subsequent reoperation within 5 years.[16] In addition, the length of time between reoperations progressively shortens after each additional

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repair. The 5-year rate of reoperation was 24% after the first reoperation, 35% after the second, and 39% after the third, and the 7-year rate after three reoperations approached 50%.[16] This data underscores the importance of minimizing the risk for subsequent reoperations by employing the best evidence-based approach to the first hernia repair.

The use of autologous tissue grafts and flaps have been described in successful repairs of abdominal fascia defects.[17,18]Disa reported reliable repairs with fascia lata autografts in the presence of contaminated wounds when prosthetic materials were contraindicated.[19] Despite the advantages of autologous fascia lata grafts, the creation of a thigh donor site and the potential for donor site morbidity decrease this technique's desirability. Additionally, although tension is alleviated in hernia repair, these grafts and flaps do not provide dynamic support of the abdominal wall. Components separation technique, initially described by Oscar Ramirez in 1990,[20] can provide this dynamic support. Lowe[21] reported that when used in a series of 30 patients, the component separation technique was associated with the need for prosthetic implantation in 33%. De Vries Reilingth[22] reported a 32% herniation recurrence rate in a series of 43 patients following component separations repairs. Mesh reinforcement with[23,24] and without[25] components separation has been shown by others to reduce hernia recurrence. This claim is reasonable because the remaining fascia is often of marginal strength and quality, and may not be reliable as a single repair layer particularly in complex defects.

In the late 1990s, biologic repair materials were introduced as a possible ventral hernia solution. Menon[26] demonstrated the benefits of human acellular dermal matrix (AlloDerm®; LifeCell, Branchburg, NJ) as a fascial interposition graft for abdominal wall reconstruction in a rabbit model. In this study, the dermal allograft became vascularized, and provided mechanical support comparable to ePTFE in ventral hernia repair. Buinewicz and Rosen[27] described the use of AlloDerm® as an interpositional and/or layered overlay patch repair for the reconstruction of abdominal fascia defects in a series of 44 patients, demonstrating a recurrence rate of only 5% with good tolerability and tissue integration. However, one problem seen in patients repaired with AlloDerm® is the recurrent laxity. This observation was reported also by Schuster who found an 83.3% recurrence in patients with contaminated hernias repaired with Alloderm®.[28]

Although the indications for incisional hernia repair are well established, controversies exist with regard to the technique of repair, specifically whether a repair should be reinforced and if so, what type of mesh should be used. Multiple factors affect the outcome of a ventral hernia repair, including the local tissue, intraabdominal environment, and systemic factors, such as a patient's overall condition. For example, multiple previous repairs, increased intraabdominal fat/pressure, a chronically infected field, and poor nutritional status are only some of the factors that can affect technique selection. To standardize the management approach to hernia repair, a ventral hernia grading scale was suggested in 2010 (►**Table 1**).[29] Component separation and biologic mesh are recommended for complicated patients, such as those having grade 2 through 4 hernia.

The combination of different types of mesh with the development and improvement in the components separation procedure allowed the development of a comprehensive

Table 1 Hernia Grading Scale[29]

Grade 1	Low risk of complications
Low risk	No history of wound infection
Grade 2	Smoker
Comorbid	Obese
	Diabetic
	Immunosuppressed
	Chronic obstructive pulmonary disease
Grade 3	Previous wound infection
Potentially contaminated	Stoma present
	Violation of the gastrointestinal tract
Grade 4	Infected
Infected mesh	Septic dehiscence

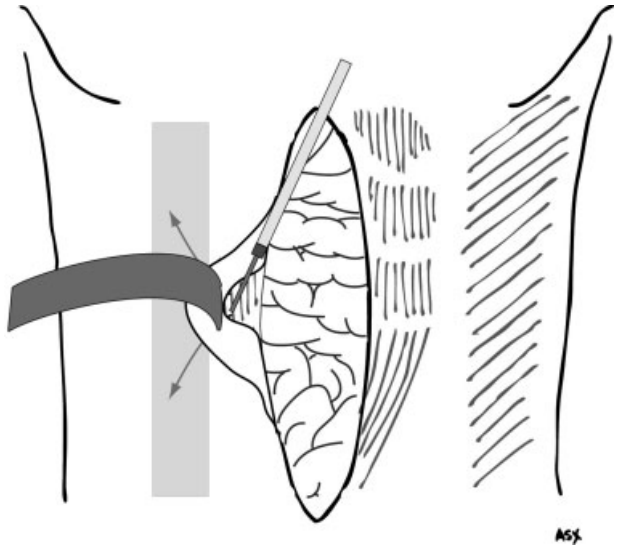

Figure 1 Subcutaneous lateral dissection through a 3 cm wide tunnel up to the linea semilunaris.

surgical technique, which allows successful management of complex abdominal wall defects. This technique is described in the following section.

Surgical Technique

All the abdominal wall reconstructive procedures are done in conjunction with a general surgery team. Close communication is maintained between the general surgery and plastic surgery teams to coordinate the location of the incision preoperatively. The general surgery team begins the surgery and proceeds with the exploratory laparotomy, lysis of adhesions, and definition of fascial edges, after which the plastic surgery team joins the operation and proceeds with minimally invasive components separations. This is achieved by a bilateral 3-cm-wide subcutaneous tunnel dissected from the midline to linea semilunaris on a subcutaneous plane superficial to the anterior rectus sheaths (►**Fig. 1**). Through this subcutaneous access tunnel on each side, the external oblique aponeurosis is incised vertically, 1.5 cm lateral to the linea semilunaris, utilizing a Bovie. The incision in the fascia is then advanced cranially up to the coastal margins and caudally with the help of a light retractor (►**Fig. 2**). Dissection in the avascular plane between the internal and external oblique muscles is also performed through the same tunnel. The plane of dissection should separate easily. The dissection between the muscles is done from the level of the pubis inferiorly to the costal margins. To avoid cutting in the subcutaneous fat while releasing the external oblique aponeurosis (usually 2.5 cm wide), tunnels are created with electrocautery and blunt dissection anterior to external oblique aponeurosis over the planned release location. This is done using narrow retractors and a light source. The external oblique aponeurosis is now isolated from surrounding tissue both anteriorly and posteriorly to the released line. Additional dissection is performed to separate the external and internal oblique muscles, and should extend laterally to the midaxillary line.

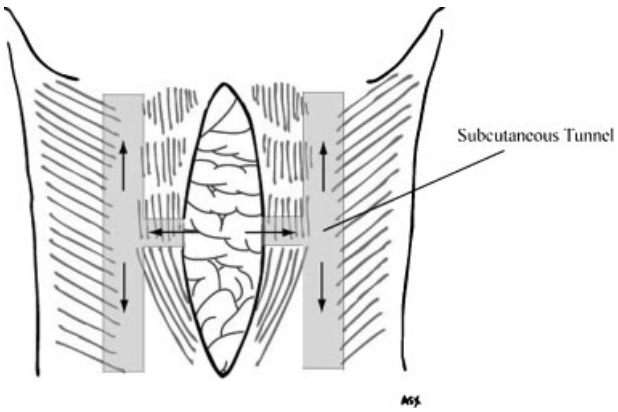

Figure 2 Subcutaneous tunnels dissected 2 cm lateral to linea semilunaris to allow the incision in the fascia as a part of the components separations.

Next, a 2 to 3 cm subcutaneous dissection from midline to laterally is done to elevate the skin flaps over the anterior rectus sheath on both sides of the defect. At this point, the medial edges of the fascia are approximated and the size of the mesh that will be used is decided. In most cases, the mesh that will be used is a biologic mesh (non-crosslinked acellular dermal matrix), which is applied as an underlay under the preperitoneal fascia with at least a 3 to 5 cm fascia overlap (►**Fig. 3**). Interrupted no.1 polypropylene sutures are placed 3 to 5 cm peripheral to the true fascial edge, through the bioprosthetic mesh and back through the musculofascia to create U stitches. All sutures are preplaced and tagged with hemostats to allow assessment and potentially adjustment of the inset tension. When the edges of the fascia can be completely closed over the mesh, no. 1 Prolene® sutures are placed in an interrupted fashion through the fascia edge to allow closure at the midline (►**Fig. 4**). To help reduce dead space and the risk of fluid collection, a 15-French black drain can be left between the mesh and the fascia. Meticulous attention should be given to avoid injury to any intraabdominal structure such as bowel. If complete musculofascial midline closure is not possible, the musculofascial edges are tacked down to the mesh using interrupted resorbable 2–0 monofilament sutures to create a " bridged" repair with the mesh spanning the defect between the musculofascial edges(►**Fig. 5**). Round closed suctions no. 19 drainage catheters are placed in each component separation and subcutaneous space. Redundant skin flaps are resected, and the remaining undermined skin flaps are closed at the midline. If the skin is under significant tension or cannot be closed, a wound VAC can be applied to allow a delayed closure of the skin envelope.

Postoperative care includes gradual diet advancement, epidural pain management transitioning to oral analgesics,

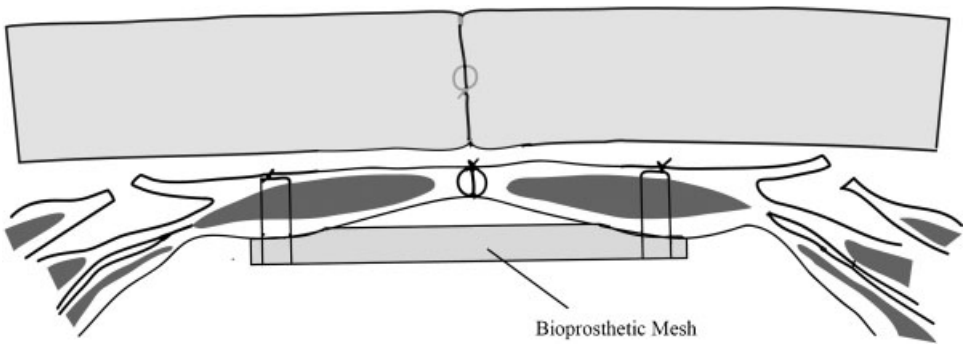

Figure 3 Completion of the ventral hernia repair with application of the mesh under the fascia with wide overlapping of the fascia, closure of the fascia at the midline and components separations.

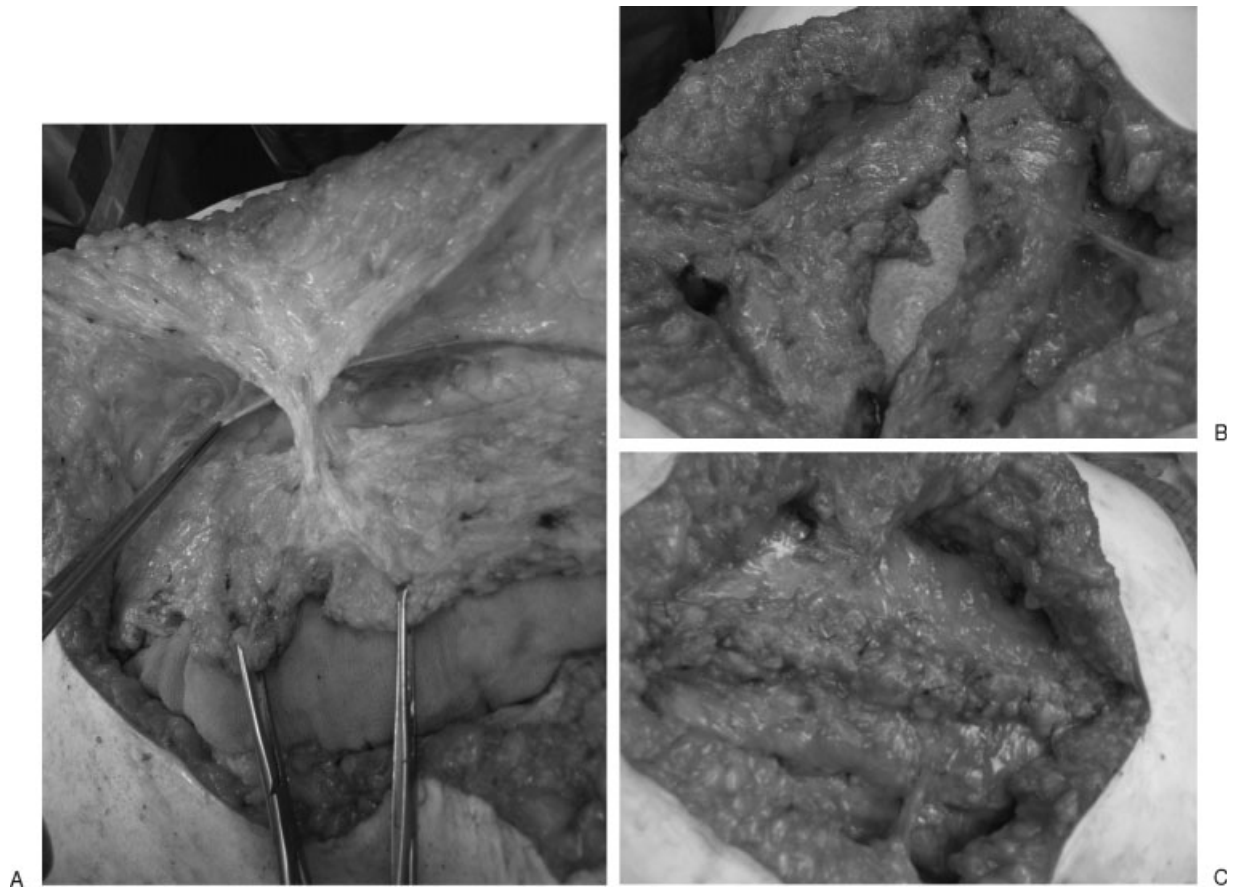

Figure 4 A 48-year-old patient with a history of multiple laparotomies and recurrent ventral hernia after two failed hernia repairs. (A) Components separation performed prior to minimally invasive components separation with preservation of the perforators to the skin. (B) Insertion of the porcine acellular dermal matrix (PADM) under the fascia with wide fascia overlap. (C) Closure of the fascia at midline over the PADM.

and early ambulation. Patients are generally discharged from the hospital on postoperative days 4 through 7. Drains are removed when the output is less than or equal to 30 cc over 24 hours, and heavy physical exercise is avoided for 8 weeks.

In a group of 41 patients with complex abdominal wall defects repaired by the senior author (LH) using the above technique, three patients developed recurrence of hernia during a follow-up period of 17 months (range 4–34 months). The biologic mesh used in all patients at our institution is the Strattice® biomesh (LifeCell Corp., Branchburg, NJ). Additional complications included eight reported infections, five cases of wound dehiscence, and two cases of seroma. There was no need to remove the biologic mesh in any of the cases with postoperative wound complications.

Currently when we assess the list of bioprosthetic meshes available, we prefer to use a noncrosslinked porcine acellular dermal matrix in challenging cases with complex defects. This type of material has yielded favorable outcomes with formation of minimal adhesions at the repair site, according to recent MD Anderson studies.[30]

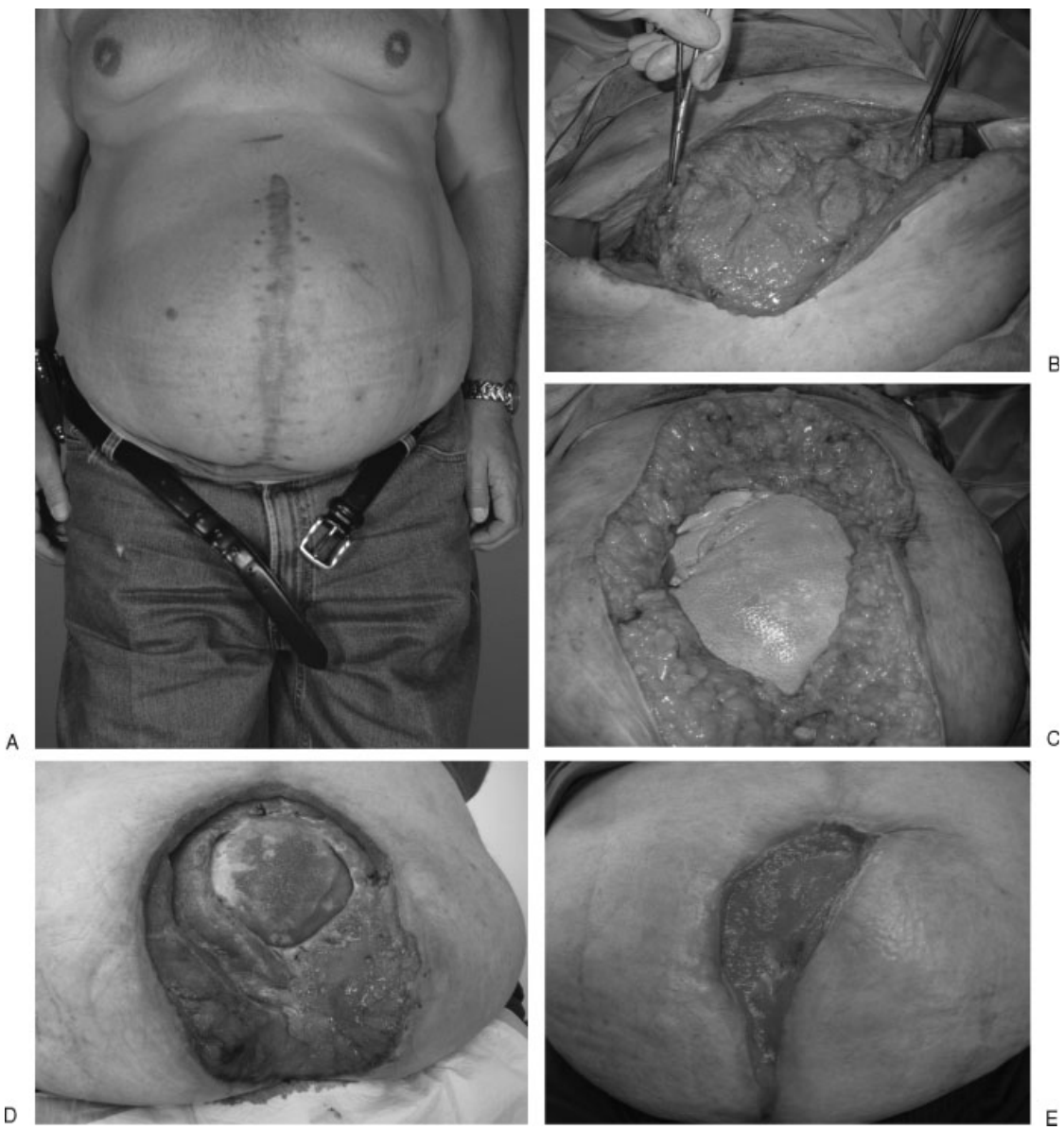

Figure 5 (A) A 50-year-old man with a history of recurrent ventral hernia exhibits loss of domain after gastric bypass and a repair of a ventral hernia with Marlex mesh. (B) Wide defect of the fascia with loss of domain. (C) Closure of the fascia after components separation and bridging with the porcine acellular dermal matrix (PADM). (D) Open wound with exposure of the PADM after dehiscence of the skin incision and after treatment with wound VAC for 3 weeks. (E) Wound with granulation tissue and decrease in size after 8 weeks of treatment with wound VAC. (F) Closed wound after treatment with split-thickness skin graft.

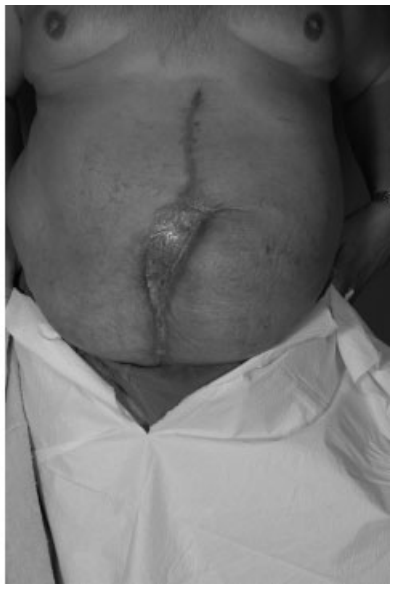

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Figure 5 *(Continued)*

Conclusion

Obviously, each technique can undergo multiple modifications based upon the surgeon's experience and the patient's particularity. However, today we are approaching a consensus in which cases of complex ventral incisional hernia are treated by a comprehensive approach that includes components separation in conjunction with a mesh applied in an underlay fashion. The increase in the complexity of cases seen for abdominal wall reconstruction mandates a multidisciplinary approach with an increase in the use of bioprosthetic mesh. Efforts continue to further the improvement in the surgical outcome of these complex cases and to decrease the morbidity associated with the above procedures.

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