

# Special REPORT

## Benefits of GORE® DUALMESH® Biomaterial in Hernia Repair:

### *A Case-based Presentation*

#### Introduction from the Faculty Chair



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Considered one of the most common types of surgery, hernia repair remains an ongoing challenge for surgeons because

of the risk for recurrence and other complications.<sup>1</sup> As a long-standing material used for hernia repair, expanded polytetrafluorethylene (ePTFE) has made strides to maximize the outcomes and address the risks. The use of ePTFE has evolved significantly since its introduction in 1983.<sup>2</sup> With early iterations, such as the GORE-TEX® Soft

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Tissue Patch (GORE®, W.L. Gore & Associates, Inc.), surgeons could apply a solid, microporous sheet of ePTFE to enhance tissue incorporation while minimizing the risk for recurrence.<sup>3</sup> With more recent configurations of ePTFE, particularly GORE® DUALMESH® Biomaterial and GORE® DUALMESH® PLUS Biomaterial (GORE®, W.L. Gore & Associates, Inc.), hernia repair has become more innovative, improving fixation to the abdominal wall and tissue ingrowth, while minimizing adhesion formation and the risk for recurrence.<sup>4</sup> Despite these developments, there are several misconceptions regarding its use and long-term outcomes, as well as the costs associated with the ePTFE material. In the past, several publications provided relevant information on the use of ePTFE, but as with many maturing prosthetic materials, surgeons may be overlooking the benefits of this long-standing material when compared with other prosthetics, such as polypropylene and polyester mesh.<sup>5</sup> Yet, with studies demonstrating an increased risk for recurrence as well as biomaterial-related complications—adhesion formation and tissue ingrowth—and bowel obstruction when using polypropylene and polyester mesh, understanding how to use ePTFE in hernia repair for different types of patients will increase awareness of the features that continue to make ePTFE the most effective option.<sup>6,7</sup>

This report will discuss the benefits of using GORE® DUALMESH® Biomaterial in hernia repair and provide evidence based on recent studies as well as clinical experience.

## **Understanding the Mechanism Behind ePTFE**

ePTFE is a fluorocarbon polymer with favorable properties—chemical inertness, a high strength-to-weight ratio, thermal resistance, and biocompatibility—that can be expanded and manipulated to modulate tissue response.<sup>8</sup> The fluorine atoms shield the carbon atoms, resulting in a low level of reactivity with other chemicals. Consequently, there cannot be chemical cleavage of the bonds or covalent chemical interactions.<sup>9</sup> The strength of the fluorocarbon bonds is an underlying characteristic of ePTFE mesh. The mesh can be placed either by laparoscopy or by an open surgical approach. Unlike sutures, mesh repair minimizes the risk for recurrence and postoperative pain, and is associated with greater patient satisfaction.<sup>10</sup> If adhesions occur, the bowel easily can be dissected free from the prosthesis without affecting other tissue or neighboring organs.<sup>11,12</sup>

Although conventional ePTFE mesh is pliable and can provide effective tissue ingrowth while minimizing inflammation and adhesion formation,<sup>5,13</sup> the GORE® DUALMESH® Biomaterial product possesses a smooth surface on the visceral side that mitigates against the development of adhesions to the material. The CORDUROY surface allows for rapid tissue ingrowth. Every surgeon is concerned about the risk for developing a prosthetic infection. The GORE® DUALMESH® PLUS Biomaterial product is the only product on the market that has antimicrobial agents impregnated within it. This has been proven to be an effective agent against methicillin-resistant *Staphylococcus aureus* (MRSA)<sup>14</sup> for up to 14 days postoperatively.

## **Characteristics of the GORE® DUALMESH® Biomaterial**

The GORE® DUALMESH® Biomaterial currently is used in hernia repair—open and laparoscopic—and temporary

bridging of fascial defects.<sup>15</sup> Unlike its ePTFE predecessors, as well as other meshes—polypropylene- and polyester-based—the GORE® DUALMESH® Biomaterial possesses a 2-sided design with one side to promote ingrowth, while minimizing adhesions on the other.<sup>4,16</sup> The GORE® DUALMESH® Biomaterial features a visceral interface side with pores less than 3 microns in size that minimize tissue attachment, and a fascial side—the CORDUROY surface—that includes ePTFE ridges that stimulate tissue fixation on the abdominal wall to create a neoperitoneal surface.<sup>4</sup> The GORE® DUALMESH® Biomaterial is soft and supple, allowing it to roll up tightly enough to be inserted into the abdominal cavity with or without the use of a trocar.<sup>17,18</sup> In the event that the patient requires radiation therapy subsequent to the hernia repair, ePTFE is able to withstand therapeutic irradiation.<sup>19</sup> The GORE® DUALMESH® Biomaterial is the only consistently visible mesh on computed tomographic (CT) scans, which provides a benefit for future evaluations of the abdominal wall to assess the need for any additional surgical interventions.<sup>20</sup>

## **Minimizing Adhesion Formation in Hernia Repair**

The barrier surface of the GORE® DUALMESH® Biomaterial is permanent and proven. One study evaluated the severity of adhesions using GORE® DUALMESH® Biomaterial at reoperation (N=65), and found that 91% of patients had filmy, avascular adhesions if they had any at all.<sup>12</sup> If one has had the opportunity to reoperate on a patient who had undergone mesh implantation, the challenge of minimizing adhesion formation to these materials is not widely publicized. These have proven to be most difficult in many patients regardless of the “tissue-separating” product being used; however, this is not the case with the GORE® DUALMESH® Biomaterial. In cases where patients require reoperation, clinicians are able to see the neoperitoneum on the visceral surface of the material.<sup>12</sup> This layer is easily penetrated to expose the underlining ePTFE surface that will appear as pristine as the day of implantation. This layer can be dissected from the mesh so that there is minimal risk for bowel injury.<sup>12</sup> This represents a unique quality of the material that is largely unrecognized.

## **Improving Recurrence Rate With GORE® DUALMESH® Biomaterial**

Recurrence is considered the most important end point in hernia repair.<sup>20</sup> With recurrence rates as high as 58%,<sup>21</sup> surgeons have benefited from the use of laparoscopy in ventral and incisional hernia repair. Heniford et al evaluated the safety and efficacy of laparoscopic ventral hernia repair in 850 patients of which 34% were recurrent hernias. GORE® DUALMESH® Biomaterial was used in 97% of patients, and the results showed a recurrence rate of 4.7% in patients at mean follow-up time of 20 months.<sup>22</sup> Additionally, patients experienced a shorter hospital length of stay (LOS, 2.3 days) and a low conversion rate to open surgery (3.4%).<sup>22</sup> Similarly, Cobb et al conducted a retrospective study (N=270) to evaluate laparoscopic ventral and incisional repairs using GORE® DUALMESH® Biomaterial.<sup>17</sup> The average patient was obese and had a large hernia (143 cm<sup>2</sup>).<sup>17</sup> Results showed that the recurrence rate for ventral hernias was 4.7% and that laparoscopic ventral hernia repair was associated with shorter LOS (3 days) and a low rate of conversion to open surgery (2.5%).<sup>17</sup>

The strength of the ingrowth of the collagen into the product is considered critical to the prevention of recurrence of herniation following the repair of these hernias with GORE® DUALMESH® Biomaterial. This has been confirmed in the laboratory. One study evaluated the use of GORE® DUALMESH® Biomaterial versus polypropylene mesh in 12 rabbits and assessed adhesions, and found that it had greater attachment strength ( $P=0.02$ ).<sup>4</sup> Additionally, the study showed that 12% of the rabbits in the GORE® DUALMESH® Biomaterial group developed adhesions on the visceral side compared with 88% of rabbits in the polypropylene group.<sup>4</sup>

### Minimizing Infection With GORE® DUALMESH® PLUS Biomaterial

In addition to hernia recurrence, one of the ongoing concerns of using prosthetic materials is the infection rate associated with hernia repair. Hospital-acquired infections, including surgical site infections, continue to be challenging, and result in increased patient pain and discomfort, longer hospital LOS, and a higher mortality rate; thus, it is imperative to identify strategies that will minimize the risk for infection while optimizing the outcomes.<sup>23</sup> Hernia repair and the use of biomaterials presents a higher potential for infection and, consequently, an increased recurrence rate. Studies show that although infection rates vary depending on whether procedures are open or laparoscopic, rates can be as high as 18%.<sup>24</sup> In cases where patients are more susceptible to infection, GORE® DUALMESH® PLUS Biomaterial has been proven effective in inhibiting bacterial colonization, while maximizing rapid tissue attachment. GORE® DUALMESH® PLUS Biomaterial is the only prosthetic material for hernia repair that incorporates an antimicrobial agent within the product.<sup>17</sup> The GORE® DUALMESH® PLUS contains both silver carbonate and chlorhexidine diacetate, which have been shown to be bactericidal to 10 different strains of organisms including MRSA, *S. epidermidis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Candida albicans*.<sup>25</sup> Harrell et al tested MRSA resistance in 9 types of mesh, including GORE® DUALMESH® PLUS Biomaterial,

Parietex® Composite (polyester/polypropylene/glycol), Marlex® (polypropylene), and Composix® (ePTFE/polypropylene), and found that GORE® DUALMESH® PLUS Biomaterial was the only mesh without detectable adherence by MRSA.<sup>14</sup> The impregnation of these agents into the biomaterial provides protection against the risk for an infection by inhibiting microbial colonization and initial biofilm formation for up to 14 days following repair.<sup>14</sup>

### Clinical Evidence on Lack of Shrinkage For GORE® DUALMESH® Biomaterial

GORE® DUALMESH® Biomaterial continues to be a mainstay of laparoscopic incisional and ventral hernia repairs. Yet, there has been criticism of the material in that there is a perception that it shrinks more than other materials used for this type of procedure. Recent studies have provided data on adult patients that address this misconception. Because ePTFE is the only prosthetic consistently visible using CT imaging,<sup>26</sup> Carter and colleagues were able to measure the size of the mesh after implantation in 65 patients undergoing CT scanning following laparoscopic incisional hernia repair with GORE® DUALMESH® Biomaterial.<sup>27</sup> It was possible to determine the actual size of the mesh after implantation using specialized software, which showed an average shrinkage rate of 7.9%.<sup>27</sup> Similarly, Schoenmaeckers et al reported that shrinkage of ePTFE in 656 patients undergoing laparoscopic hernia repair was only 7.5% when measured by CT scan.<sup>26</sup>

Since the introduction of the ePTFE, a number of studies have outlined its characteristics and demonstrated its use for hernia repair in optimizing outcomes in different types of patients. This report will address many of the current uses of GORE® DUALMESH® Biomaterial, including parastomal hernia repair, re-operative procedures in the presence of mesh, and complex abdominal wall repairs. Certainly, there are many surgeons who do not believe that a product is better just because it is new. More importantly, however, the science as well as a product's track record should provide guidance when selecting a prosthetic material to repair any and all hernias.

## Case 1

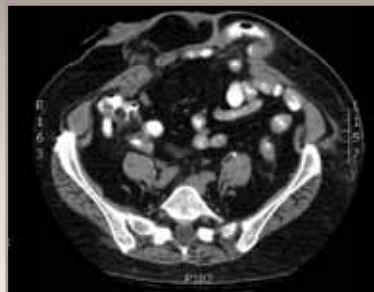
### An 85-year-old man undergoing parastomal hernia repair.



**Alfredo M. Carbonell, DO**

The patient had a history of invasive bladder carcinoma. Twelve years ago, the patient had undergone a radical cystoprostatectomy with an ileal conduit urinary stoma. He presented with both a midline incisional and a recurrent parastomal hernias. He had undergone 2 failed open non-mesh attempts at parastomal hernia repair in the past (Figure 1). After discussing open and laparoscopic options, the patient chose laparoscopy.

A laparoscopic Sugarbaker repair was performed. Taking into account the midline incisional defect, the hernia defect area measured 11 x 9 cm (Figure 2). The GORE® DUALMESH®



**Figure 1.** Computed tomographic scan image demonstrating both the parastomal and midline incisional hernia defects.

Biomaterial was chosen for the repair as it is the most proven mesh for the laparoscopic repair of parastomal hernias, and its laminar mesh structure prevents an aggressive mesh–bowel inflammatory reaction, thus preventing bowel erosion.<sup>28</sup> The GORE® DUALMESH® Biomaterial was trimmed to a size measuring 18 x 21 cm. Cardinal sutures were placed along the edges of the mesh and paired sutures were placed along the side of the mesh where the bowel would exit (Figure 3). The mesh was positioned against the abdominal wall using both permanent sutures and tacks (Figures 4 and 5). Total operative time was 98 minutes, and postoperatively the patient did very well and was discharged home after a 4-day hospital stay. At the 4-year follow-up, the patient remained free of cancer and without any recurrence.

## Discussion

The laparoscopic Sugarbaker parastomal hernia repair is a durable hernia repair option. The physical properties of GORE®

DUALMESH® Biomaterial with its laminar construction make it the safest mesh to use for this technique and this has been borne out in the clinical literature.<sup>16,28</sup> Parastomal hernias pose a unique problem for general surgeons because unlike other types of hernias of the abdominal wall, the defect needs to be covered completely while still allowing a functional portion of the intestine to exit the abdominal wall through that very same defect. The Sugarbaker parastomal hernia repair technique accomplishes this task by positioning the mesh directly against the abdominal wall, while allowing the bowel segment to course in between the mesh and the abdominal wall. The bowel then re-enters the peritoneal cavity through a sling or shower curtain deformity between the mesh and the abdominal wall. Because the bowel essentially is draped over the edge of the mesh, the mesh has to have certain properties to avoid mesh–bowel erosion.

## Conclusion

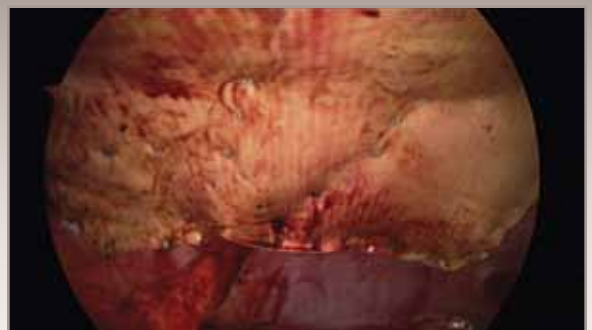
For years, GORE® DUALMESH® Biomaterial has been the most consistently used type of mesh for laparoscopic incisional hernia repair as well as parastomal hernia repair, particularly,



**Figure 2.** Intraoperative photo demonstrating the parastomal hernia defect.



**Figure 3.** GORE® DUALMESH® Biomaterial with cardinal sutures in place prior to implant.



**Figure 4.** GORE® DUALMESH® Biomaterial in position against the abdominal wall.



**Figure 5.** Immediate postoperative photo demonstrating the laparoscopic incisions and the transabdominal fascial suture site incisions.

the Sugarbaker technique.<sup>28,29</sup> GORE® DUALMESH® Biomaterial is a nonporous, laminar mesh structure, which allows for adequate mesh ingrowth, without the dense adhesions seen with other mesh types.<sup>30,31</sup> Although the macroporous or corduroy side of the mesh is placed in direct contact with the bowel, the mesh does not erode into the bowel. Despite its many years of use, there have been no reported events of spontaneous GORE® DUALMESH® Biomaterial–bowel erosion as have been seen with both polyester and polypropylene-based meshes.<sup>32</sup> Its laminar structure prevents the mesh from growing into the bowel, despite the continuous peristalsis of the bowel across the mesh edge.

## Q&A

**Dr. LeBlanc:** Do you prep the bowel in these patients?

**Dr. Carbonell:** No. A bowel prep is traditionally used to decrease the chance of wound infection or anastomotic leaking at the time of bowel resection or reanastomosis. Not only have studies demonstrated the opposite to be true, but we also

are not opening the bowel during parastomal hernia repair. If one was to injure the bowel during the repair, it would be inadvisable to proceed with mesh implantation anyway. Hence, bowel prep is not useful.

**Dr. LeBlanc:** How far apart are the sutures placed?

**Dr. Carbonell:** We have traditionally used a spacing of every 5 cm or so for standard laparoscopic incisional hernia repair, the thought being that if the mesh stays where you place it, the hernia is unlikely to recur. The only way to ensure that the mesh stays where you place it is to use multiple, permanent, trans-abdominal fascial sutures.

**Dr. LeBlanc:** Do you place an abdominal binder on these patients postoperatively? If so, how long do you make them wear it?

**Dr. Carbonell:** Binders have not been shown to decrease seroma, but in some patients it helps them feel like they have support of their abdomen while they ambulate. If the binder is comfortable for them, I have these patients wear it for support for approximately 6 weeks.

## Case 2

### A 39-year-old man with a large recurrent midline incisional hernia.

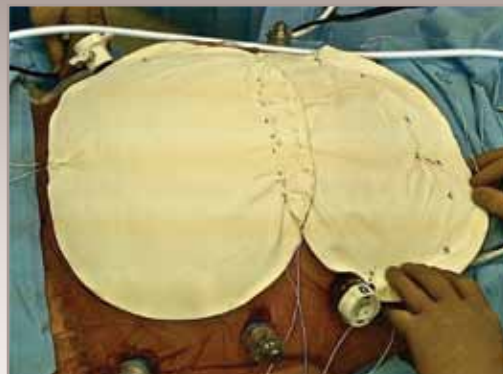


**Carl R. Doerhoff, MD**

The patient was morbidly obese with a body mass index (BMI) of 40 kg/m<sup>2</sup> (height: 68 inches, weight: 120 kg). A construction worker, the patient was on medical disability. Significant past medical history included a prior colostomy and subsequent subtotal colectomy with J-Pouch for ulcerative colitis in 1998. He reported having 15 abdominal operations with multiple attempts at hernia repair, including multiple mesh failures. In 2009, he underwent a repair using the components separation technique with polypropylene but he developed yet another recurrence. He had a second repair using the components separation technique in early 2010 using biologic mesh. Following this operation, he developed a large wound infection that was treated with damp-to-dry dressings and healed by secondary intention.

When the patient was referred and first examined in July 2010, he had a large abdominal wall defect, an exceedingly thin, weeping re-epithelialized wound, and a central “mass” of contracted polypropylene measuring 2 x 8 inches. His CT scan showed a meshoma with surrounding inflammation.

In August 2010, the patient underwent operation to remove the infected polypropylene and biologic mesh and excise the thin re-epithelialized skin. The patient’s midline incisional defect and left-sided colostomy hernia were closed using a No. 1 absorbable monofilament. The incision was left open; however, despite negative pressure wound therapy and damp-to-dry dressings, the wound continued to have a draining sinus tract. In November 2010, the patient underwent operation to remove an infected polypropylene stitch. This time, his wound healed with damp-to-dry dressings. A follow-up CT scan showed no residual mesh or inflammation but did show an abdominal wall defect measuring 22 x 32 cm. The residual



**Figure 6.** Large recurrent midline incisional hernia repaired using 2 pieces of GORE® DUALMESH® PLUS Biomaterial (26 x 34 cm).

abdominal wall could not be medialized to decrease the size of his defect. Consequently, the defect had to be bridged with a piece of mesh that could withstand significant intraabdominal pressure and protect abdominal viscera.

In February 2011, the patient’s hernia was repaired laparoscopically, using 2 pieces of GORE® DUALMESH® PLUS Biomaterial, each measuring 26 x 34 cm. The first 2.5 hours of the procedure required extensive adhesiolysis. The falciform ligament was taken down and the urinary bladder was mobilized posteriorly. Outside the abdomen, the 2 pieces of GORE® DUALMESH® PLUS Biomaterial were oriented transversely, overlapping by 5 cm, and affixed to one another with 22 interrupted stitches of CV-0 GORE-TEX® Suture (Figure 6).

Cardinal stitches of CV-0 GORE-TEX® Suture were placed at 6 locations on the mesh. The conjoined pieces of mesh were introduced into the abdomen through a 15-mm trocar site. Cardinal stitches were brought transabdominally, using a GORE® Suture Passer. The edge of the mesh was then positioned using an absorbable tacker. The caudal portion of mesh was affixed to the pubis and Cooper's ligaments with a nonabsorbable tacker. Next, 25 transfascial CV-0 GORE-TEX® Sutures were placed circumferentially around the 2 pieces of mesh using a GORE® Suture Passer. Last, a double crown of 300 nonabsorbable tacks was placed circumferentially. All skin incisions were closed using running nonabsorbable sutures. The entire operation was completed in 5 hours. The patient had an uneventful hospital course and was discharged on postoperative day 5.

## Conclusion

This operation demonstrates that bridging is still a viable alternative even for the largest of multiple recurrent hernias.

## Q&A

**Dr. LeBlanc:** Do you attempt to make the obese patients lose weight prior to surgery?

**Dr. Doerhoff:** Typically, yes. Especially if they have failed more

than one repair or if their BMI is greater than 45 kg/m<sup>2</sup>. Studies have shown that the recurrence rate in the obese population can be as high as 50%. Although some patients refuse to lose weight, a durable laparoscopic repair can be done.

**Dr. LeBlanc:** Why did you choose the laparoscopic approach rather than an open approach to this hernia?

**Dr. Doerhoff:** I'm not a personal fan of open repair because of increased risk for infection, seroma, and wound complications. The laparoscopic repair allows me to visualize the complete abdominal wall and identify any additional smaller hernias, as well as "Swiss cheese" defects. Therefore, I do a better job of overlapping a defect laparoscopically. Additionally, studies of incisional hernias have shown that covering the entire prior incision may reduce recurrence.

**Dr. LeBlanc:** Do you think that the PLUS product was the ideal product for this individual and why?

**Dr. Doerhoff:** I always feel better adding an antimicrobial barrier (silver and chlorhexidine) to the mesh in a patient who has had a previous mesh infection. Additionally, studies have shown a higher incidence of wound infections in the obese population. The antimicrobial technology has been shown to be effective against both gram-positive and gram-negative bacteria as well as MRSA for up to 14 days postoperatively.

## Case 3

### A 66-year-old obese woman undergoing parastomal hernia repair.



**Birgitta Hansson, MD**

The patient had a BMI of 33 kg/m<sup>2</sup> and suffered from rheumatoid arthritis. The latter was treated with steroids. Five years ago, a Hartmann's procedure was performed to manage acute diverticular disease with perforation and peritonitis. The patient complained of pain caused by the stretching of the abdominal wall and poor fitting of the appliance, resulting in leakage and peristomal skin irritation. Furthermore, she reported to have cosmetic problems that caused her quality of life to decrease significantly since the hernia became symptomatic. Clinical examination showed a huge parastomal hernia in the left lower abdomen. The hernia could not be reduced.

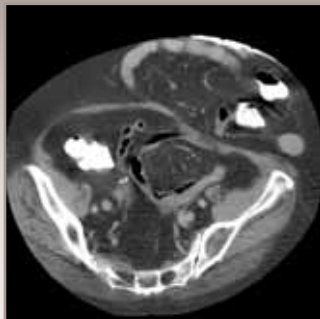
A CT scan was performed to measure the hernia and rule out concomitant incisional hernias because these could not be palpated at clinical examination. The results showed a hernia of more than 5 cm with herniation of the small bowel and an incisional hernia in the lower abdomen (Figure 7). Because of her growing complaints, a laparoscopic approach was determined to be optimal, and both hernias were repaired using 2 separate pieces of GORE® DUALMESH® Biomaterial. The parastomal hernia was repaired using the Sugarbaker technique, by which the mesh covered the hernia opening with an overlap of 4 cm on each side once the stoma loop was lateralized. The double crown technique was used for the incisional hernia. The postoperative course was uneventful. Figure 8 shows the postoperative result after the Sugarbaker technique.

## Discussion

A parastomal hernia is a common complication after stoma formation. Risk factors are obesity, chronic cough, or when the created size of the stoma opening is too wide. A symptomatic parastomal hernia can be treated by relocating the stoma, or by local reinforcement of the abdominal wall with a prosthetic mesh. Stoma relocation involves relaparotomy and replacement of the stoma to the contralateral side. In addition to the risk for developing an incisional hernia at the midline or at the old ostomy site (20%-30% of all cases), this technique carries a recurrence rate of up to 36%.<sup>33,34</sup>

Mesh repair has a lower recurrence rate. Depending on technique and placement, recurrence rates vary between 6.9% and 17.8%, and the overall mesh infection rate is 2.3%.<sup>28</sup> The mesh can be placed in an onlay, retromuscular, or intraperitoneal position, either by laparoscopy or open approach. A review of the literature finds no significant advantage of one approach over the other, while randomized controlled trials have proven to be lacking.<sup>28</sup> The laparoscopic approach is safe and feasible and causes minimal damage to the insufficient abdominal wall.<sup>35</sup>

GORE® DUALMESH® Biomaterial is used to reinforce the abdominal wall. GORE® DUALMESH® Biomaterial is the most often used prosthetic material in parastomal hernia surgery because it is soft and pliable and easy to handle. It results in less severe adhesions to the viscera compared with polypropylene meshes.<sup>16</sup> If adhesions occur, the bowel can easily be dissected free from the prosthesis.<sup>11</sup> A potential drawback of



**Figure 7.** Preoperative CT scan of obese patient with parastomal hernia.



**Figure 8.** Postoperative CT scan with ePTFE patch.

GORE® DUALMESH® Biomaterial is risk for infection.<sup>13</sup> In the only prospective series reporting on the laparoscopic repair of 55 parastomal hernias with an ePTFE patch, prosthetic infection was found in 3.6%.<sup>35</sup> Once the mesh is infected, it should be removed. In general, infection of the mesh is not a major issue in a laparoscopic ventral or parastomal hernia surgery because it is considered to be a clean operation. Although when a bowel injury with fecal spill occurs, we recommend postponing mesh implantation for at least 6 weeks.

### Conclusion

When performing a parastomal hernia repair, surgeons can use a mesh with or without a slit. The former technique also is called the “keyhole technique.” Unfortunately, this technique has a high recurrence rate caused by progressive widening of the central keyhole. Recurrence rates of more than 30% have been reported.<sup>28,36</sup> In 1985, Sugarbaker described the non-slit technique by which a mesh is used to cover the hernia opening with an overlap of 4 cm on each side, after the stoma loop is lateralized (Figure 8).<sup>37</sup> A considerably lower recurrence rate of 11.6 % was reported.<sup>28</sup> Recently, the use of biologic grafts in parastomal hernia repair has been published. Review of the literature, however, does not show better outcomes with the more expensive biologic materials.<sup>38</sup>

Therefore, the Sugarbaker technique with GORE® DUALMESH® Biomaterial is an effective technique.

### Q&A

**Dr. LeBlanc:** Do you ever use transfascial sutures for these procedures? If so, when do you decide to do so?

**Dr. Hansson:** Yes, I always use 2 nonresorbable sutures (Prolene 2.0) at the most lateral border of the mesh, at the left and right side of the “lateralized” bowel. Besides this, the mesh is fixed with titanium tacks (ProTack).

**Dr. LeBlanc:** Do you make an attempt to close the hernia defect in these cases?

**Dr. Hansson:** Nowadays, I don’t close the defect anymore. I did in my study on the keyhole technique and after a while we noticed that the sutures disrupted. Since then, I prefer a tension-free repair. In the study, we operated on 55 consecutive patients with a symptomatic parastomal hernia using the keyhole technique (see also references). We closed the defect using a non-resorbable suture 0. We reoperated on 9 out of 55 patients because of a recurrent symptomatic hernia. During reoperation, we found that the sutures were disrupted and the mesh was everted due to the high intraabdominal pressure. We concluded that suturing the defect only has temporary result, after a while sutures disrupt. That’s why we believe that a tension-free repair is best.

## Case 4

### A 62-year-old woman with cirrhosis and massive hepatitis C virus–related (Child B) ascites undergoing intraperitoneal incisional hernia repair.



**Antonio Iuppa, MD**

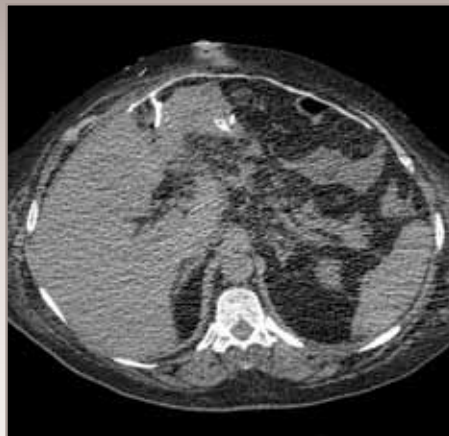
The patient underwent colon resection for a perforation resulting from diverticulitis 10 years ago. She developed a giant incisional hernia with skin ulceration and high risk for spontaneous evisceration (Figure 9). On admission to the hospital, the patient’s bilirubin and albumin levels were 2.5 mg/dL and 2.8 g/dL, respectively. The antithrombin III level was normal, and there was no previous history of bleeding.

Initial management included sterile occlusive dressing, fluid repletion, and antibiotic administration. The attempt to reduce ascites with medications failed. A peritoneovenous shunt was implanted 1 week before the repair with satisfactory results with a significant reduction of the ascites.

The initial plan was to perform a suprafascial extraperitoneal repair in order to avoid the opening of the peritoneum; however, the preservation of the peritoneum was impossible thus requiring an intraperitoneal approach. The procedure started



**Figure 9.** Preoperative CT scan showing the ascites and the hernia.



**Figure 10.** Postoperative CT scan showing the position of the mesh and the shunt.

with the creation of a plane between the muscular fascia and the subcutaneous tissue so that the mattress stitches would not have to pass through the skin. The hernia sac was opened but not resected so that it could cover the mesh at the end of the operation. A posterior plane was created on the posterior face of the abdominal wall, detaching the adhesions, the falciform ligament, and the bladder. Once this posterior support area was created, the size of the defect was measured. It was determined that the prosthesis should be 4 to 5 cm larger than the defect, enabling gentle retraction of the margins without causing excessive tension. In this case, the GORE® DUALMESH® PLUS Biomaterial, measuring 26 x 36 cm, was used to avoid leakage of ascitic fluid.

The fixation of the mesh was performed with nonresorbable monofilament material. The suture was passed in U-shape from the abdominal wall to the mesh about 4 cm from the margin of the defect, covering the entire circumference of the defect. After ensuring that the tension was uniform across the entire mesh, the residual hernial sac covered the mesh using interrupted reabsorbable stitches. This step separated the mesh from the subcutaneous tissue and supported the migration of fibroblasts into the mesh (Figure 10).

The patient had an uneventful recovery except for the appearance of a subcutaneous hematoma that did not require surgical intervention.

## Conclusion

One of the most challenging situations in patients with incisional hernias is the presence of cirrhosis and ascites. Abdominal wall repair in a patient with advanced cirrhosis presents an operative risk of great magnitude and may pose a considerable technical problem when complicated by the leakage of ascitic

fluid, necrosis of the abdominal wall with ulceration, rupture, strangulation, or infection.

Management of umbilical hernias in patients with cirrhosis and ascites remains difficult as these patients often have advanced liver disease and are at greater risk for complications following any surgical intervention. Elective surgical repair prevents complications, whereas morbidity after emergency surgery is up to 30%.<sup>39-41</sup> Repair should be performed after optimal management of ascites, which includes fluid and salt restriction, diuretics, and possibly undergoing a transjugular intrahepatic portosystemic shunt procedure before surgery, if the ascites are difficult to control with medical therapy.

## Q&A

**Dr. LeBlanc:** What type of antibiotic coverage did you administer to this patient?

**Dr. Iuppa:** I administered vancomycin hydrochloride (2 g daily for 3 days), a nonabsorbable antibiotic that is effective against anaerobic gram-negative rods. It is useful in controlling portal systemic encephalopathy in patients with cirrhosis. It also has been shown that changes in blood ammonia concentrations correspond very well with changes in the number of anaerobic gram-negative rods in feces.

**Dr. LeBlanc:** Are the antimicrobial agents in the PLUS material essential in cases such as this one?

**Dr. Iuppa:** The GORE® DUALMESH® PLUS Biomaterial is the only 2-sided, prosthetic material with antimicrobial agents (chlorhexidine and silver) that act synergistically to inhibit bacterial colonization and resist initial biofilm formation on the biomaterial for up to 14 days following implantation. This is of great importance when used in immunodepressed or debilitated patients such as those with cirrhosis.



## Case 5

## A 48-year-old man undergoing continuous ambulatory peritoneal dialysis after ventral hernia repair.

**Srdjan Rakic, MD, FACS**

The patient had undergone open sublay repair of a midline suprapubic incisional hernia using a polypropylene mesh (15 x 10 cm), and a laparoscopic repair of a large incisional hernia at midline incision using GORE® DUALMESH® Biomaterial measuring 20 x 30 cm.<sup>42</sup> Because the patient refused hemodialysis and kidney transplantation was not an option given the patient's poor vascular status, continuous ambulatory peritoneal dialysis (CAPD) was indicated.<sup>42</sup> Being aware of the potential risk for infection, it was essential to avoid compromising the GORE® DUALMESH® Biomaterial while inserting the CAPD catheter. A CT scan was used to determine the precise position of the mesh (Figure 11) and, consequently, to preoperatively draw a sketch of the mesh on the abdominal wall of the patient (Figure 12). With the mesh outlined, the CAPD catheter was implanted laparoscopically using 2 trocar ports that were positioned left laterally in the abdomen, while avoiding the GORE® DUALMESH® Biomaterial.<sup>42</sup> Intraoperatively, the mesh was completely covered with intact neoperitoneum and omental adhesion.<sup>42</sup> The procedure was carried out uneventfully. During the next 2 years, the patient experienced occasional episodes of CAPD-related peritonitis, requiring removal (3 times) or reinsertion (2 times) of the catheter.<sup>42</sup> The latter procedures were performed using the same technique as the initial insertion of the CAPD catheter: left or right (Figure 13). In all instances, the mesh was left undisturbed and remained uninfected.

**Conclusion**

This case highlights the importance of a radiopaque mesh for subsequent insertion of a catheter for CAPD. Abdominal surgery after laparoscopic ventral or incisional hernia repair (LVHR) can be challenging and requires careful planning and

execution. A detailed preoperative assessment of the position and size of the previously implanted mesh is highly desirable. ePTFE mesh has the unique property of being revealed by CT scan due to its density and structure.

Reoperations in patients with a previous LVHR carry a risk for mesh contamination and infection. Therefore, it is imperative to avoid an incision through a mesh or coming into contact with it whenever possible, in order to minimize the risk for contamination. In this specific case, the ability to radiologically visualize the existing mesh provided the ability to safely insert a CAPD catheter 3 times and at 3 different sites, despite only having access to a relatively small portion of the abdominal wall during the procedure.

**Q&A**

**Dr. LeBlanc:** Is it true that this is the only product that is truly "visible" on CT scans?

**Dr. Rakic:** Yes. Visibility of meshes or the property of being revealed by high-resolution imaging techniques such as CT or MRI is determined by 2 factors: predominantly by specific properties of mesh itself and, to a lesser degree, by a host inflammatory reaction generated by implanted prosthesis.

The most important properties of a mesh that determine its radiologic visibility are the density, structure, and thickness of the material used to produce a mesh. The only meshes that are always visible are GORE® DUALMESH® and GORE® DUALMESH® PLUS because of the high density of the material (ePTFE), its homogenous structure (nonwoven/not knitted), and its thickness (1, 1.5, or 2 mm). This feature allows for very precise and reliable measurements of mesh dimensions, position, and overlap.

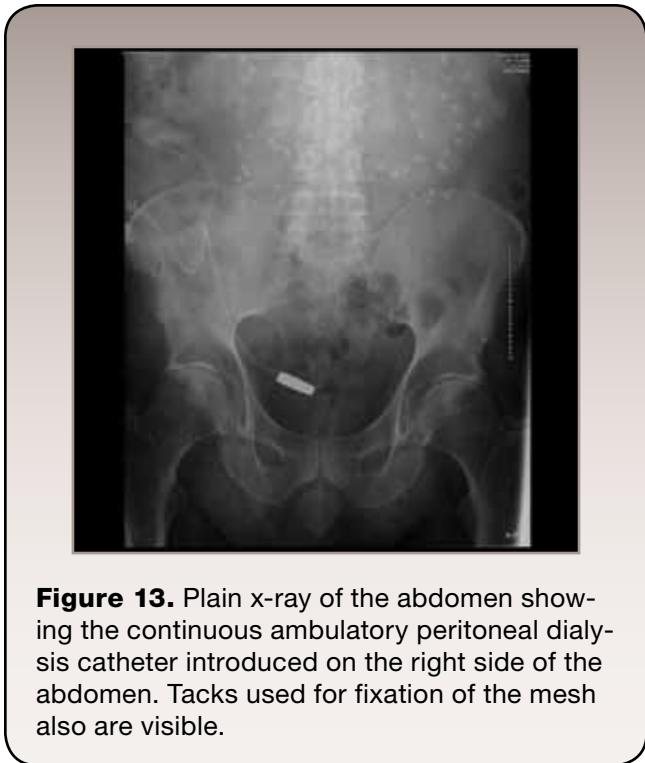
**Figure 11.** Preoperative CT scan showing position of the mesh.**Figure 12.** Preoperative sketch of the mesh on the abdominal wall of the patient.

The visibility of composite meshes containing ePTFE component (Composix, Ventralex, Intramesh T1, Dulex) is less consistent: Because the ePTFE component is much thinner ( $\leq 0.20$  mm), they sometimes are clearly visible, whereas at other times they are not. As a general rule, these meshes easily can remain unrecognized when not specifically sought after and vice versa. Less reliable and less consistent visibility of these meshes do not allow for precise radiologic measurements compared with the first group.

All other meshes in general are not visible due to their iso-attenuity relative to surrounding structures. Indirect evidence of mesh presence occasionally can be recognized, especially with MRI, due to the intense inflammatory response surrounding and incorporating the mesh (eg, scar tissue, meshoma). However, precise and reliable measurements of mesh dimension, position, and overlap are impossible.

**Dr. LeBlanc:** In your mind, does the fact that this material did not become infected despite the episodes of peritonitis prove that there is no more susceptibility to infection with this material compared with other prosthetic materials?

**Dr. Rakic:** Possibly. I assume that every mesh placed into the abdominal cavity will be covered with some sort of neoperitoneum within a relatively short period. Complete neoperitonealization of mesh might well be crucial in protection against mesh infection. If this is really true, it is probably irrelevant as to which mesh is lying under neoperitoneum.



**Figure 13.** Plain x-ray of the abdomen showing the continuous ambulatory peritoneal dialysis catheter introduced on the right side of the abdomen. Tacks used for fixation of the mesh also are visible.

## Case 6

### Two patients undergoing giant abdominal wall desmoid resection and abdominal wall reconstruction.



**Songzhang Ma, MD**

**A** 31-year-old woman was diagnosed as having a giant desmoid tumor measuring 25 cm in diameter infiltrating the thickness of the abdominal wall (Figure 14). A complete tumor excision was performed and the abdominal wall was reconstructed using GORE® DUALMESH® Biomaterial measuring 20 x 30 cm (Figure 15).

A 25-year-old woman had undergone an abdominal wall desmoids resection 3 years prior to reoperation. Myocutaneous

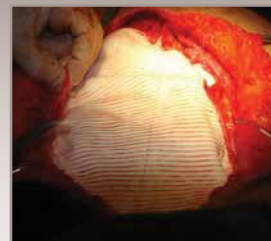
flaps covered the defect. The tumor was recurrent in situ from the previous year and quickly developed a mass measuring 12 cm in diameter (Figure 16). The tumor was resected carefully and completely, and the abdominal wall was reconstructed using GORE® DUALMESH® Biomaterial measuring 18 x 24 cm (Figure 17).

GORE® DUALMESH® Biomaterial was secured to the deep fascial elements using interrupted 1-0 Prolene sutures, and subcutaneous closed suction drains were placed.

With both patients, the procedures were done successfully. The postoperative period of both patients was uneventful and without any serious complications (eg, seroma or infection).



**Figure 14.** A giant desmoid measuring 25 cm in diameter infiltrating the thickness of the abdominal wall.



**Figure 15.** GORE® DUALMESH® Biomaterial was used to reconstruct the abdominal wall.



**Figure 16.** A recurrent desmoid tumor 3 years prior to reoperation.

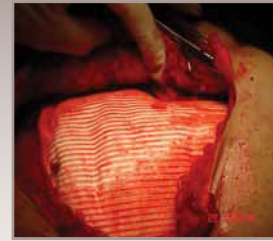
Postoperative treatment included sulindac 200 mg twice daily and tamoxifen 20 mg daily. At the 24-month follow-up, there was no desmoid recurrence on the abdominal wall. Inspiration and expiration tests were used to measure the patients' abdominal wall compliance, and the results showed that the abdominal wall was functioning well without any feeling of stiffness in both patients. At 6 months, however, a CT scan indicated a newly developed tumor on the mesentery in the 25-year-old patient.

## Conclusion

GORE® DUALMESH® Biomaterial was selected for abdominal wall reconstruction based on its following features considered ideal for the repair:

- Mesh pliability and compliance
- Tensile strength
- Biocompatibility
- Minimal adhesion with tissue and organs to the material
- Firm tissue attachment and ingrowth

Superficial desmoid tumors should be resected before they become large. The reconstruction of the abdominal wall with large soft tissue defects is usually very complicated and can be performed immediately using myocutaneous flaps or synthetic meshes. Because positive margins were associated with a 2-fold increased risk for local tumor recurrence, additional resection on surrounding tissue should be completed. Pathologic examination of the specimens of our patients confirmed



**Figure 17.** GORE® DUALMESH® Biomaterial is used to reconstruct the abdominal wall with interrupted 1-0 Prolene sutures.

the presence of 2 to 3 cm margins of normal tissue around the tumor.

## Q&A

**Dr. LeBlanc:** How long were the drains left in place?

**Dr. Ma:** The time at which to pull the drainage tube is determined by the amount of drainage. If drainage is less than 20 mL per day, it can be considered. In case 1, the drainage tube was retained for 7 days. In case 2, it was retained for only 3 days. Because of the large surgical wound, tube retention depends on the clinical signs. After pulling the tube out, an ultrasound or CT scan may be necessary. If any fluid remains in the abdominal cavity around the mesh, additional treatment may be required. In case 1, a CT scan showed a small amount of fluid but did not require further treatment.

**Dr. LeBlanc:** If you have to reoperate on patients such as these, what do you recommend for closure of the DUALMESH®?

**Dr. Ma:** This is a good question. In my opinion, if abdominal surgery is required, the conventional method to open and close the abdominal wall is acceptable. If the reoperation is for recurrence of tumor, removal of the tumor is performed first, and then repair the subsequent abdominal defect with a new mesh. It is easy to separate the adhesion between the GORE® DUALMESH® Biomaterial and the organ surface; the healed area with mesh in the abdominal wall can still be closed by using continuous sutures.

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**Financial Disclosures:**

Dr. LeBlanc reported that he is a consultant and on the speakers' bureau for W.L. GORE, CR Bard, and Covidien. He also is on the medical advisory board for Via Surgical. Dr. Carbonell reported that he is a consultant and on the speakers' bureau for W.L. GORE and a consultant for Ethicon Endo-Surgery and Bard Davol. Dr. Doerhoff reported that he is on the speakers' bureau for W.L. GORE, Ethicon Endo-Surgery, and Covidien. Drs. Hansson, Iuppa, Rakic, and Ma reported no relevant financial conflicts of interest.

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