Open Preperitoneal Retrofascial Mesh Repair for Multiply Recurrent Ventral Incisional Hernias

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BACKGROUND: Because herniorrhaphy failure and complication rates appear proportional to the number of previous repairs, multiply recurrent hernias (MRH) represent a formidable challenge. We sought to determine the safety and efficacy of open preperitoneal retrofascial mesh repair of MRH.

STUDY DESIGN: We conducted a retrospective review of consecutive patients undergoing an open preperitoneal retrofascial mesh repair of multiply (two or more) recurrent hernias at a tertiary care referral center.

RESULTS: From January 2001 to May 2005, 128 patients underwent surgical repair of an MRH; 32 of these underwent an open preperitoneal repair. The average body mass index was 39.1 ± 8.4 kg/m² (range 28.9 to 61.0 kg/m²). All patients had significant comorbidities; 18.8% were smokers. The number of previous herniorrhaphies was 3.6 (range 2 to 24). Polypropylene mesh was used in all patients, including lightweight polypropylene in 10 (31.2%) patients. The average mesh size was 937 ± 531 cm² (range 225 to 1,800 cm²). There were no major intraoperative complications. Wound infection occurred in 4 patients (12.5%, all smokers), requiring partial mesh excision in 1 patient. Univariate analysis revealed smoking as the only predictor of wound or mesh-related morbidity (p = 0.0004). At a mean followup of 28.1 months (range 8 to 60 months), there has been 1 recurrence (3.1%) in the patient requiring partial mesh removal.

CONCLUSIONS: Open preperitoneal retrofascial mesh repair resulted in an effective herniorrhaphy with low perioperative morbidity in patients with MRH. Smoking cessation appears to be important in minimizing infectious complications. Given the technical challenge, surgical care of patients with MRH may be best provided in referral centers with interest and expertise in complex hernia repairs. (J Am Coll Surg 2006;203:283–289. © 2006 by the American College of Surgeons)

Ventral abdominal hernias represent a frequently encountered and often formidable clinical problem. Reported failure rates of primary suture repair range between 25% and 52%. Given the increased morbidity and higher failure rates for patients with recurrent hernias, use of mesh reinforcement of the abdominal wall should be mandatory in the vast majority of patients today. Several randomized, prospective trials have demonstrated a doubling in recurrence rates if mesh is not used. Traditional mesh placement strategies in an overlay or underlay fashion have often prevented adequate mesh-to-defect overlap. Extraperitoneal placement of a prosthetic between the rectus muscles and posterior rectus fascia, popularized by Rives and colleagues and Stoppa, allows for use of a large mesh with significant overlap. The Rives-Stoppa technique has become a popular approach for open ventral herniorrhaphy for many hernia surgeons, with recurrence rates of 1% to 14%. We have developed a method, also recently reported by other investigators, that resembles the Rives-Stoppa technique. Our approach involves mesh placement in the preperitoneal space, as opposed to the space anterior to the posterior rectus fascia (Fig. 1). This modification of the Rives-Stoppa

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technique allows for substantial retrofascial coverage of the defect in a near bloodless plane.

Because the same factors that predispose patients to hernia development likely contribute to recurrences, herniorrhaphy failures often occur in patients with significant comorbidities, such as obesity, diabetes, steroid use, and seen. As a result, recurrent ventral hernias frequently represent a formidable surgical problem. Because herniorrhaphy failure rates are proportional to the number of previous repairs, multiply recurrent hernias are an even greater challenge. We hypothesized that an open preperitoneal retrofascial mesh repair of multiply recurrent ventral hernias is safe and effective in preventing hernia recurrence.

METHODS

Study design and data acquisition
After receiving approval from the Institutional Review Board, a retrospective review of all patients who underwent open ventral hernia repair between January 2001 and May 2005 was performed. Patients who underwent open preperitoneal repair of a multiply recurrent hernia (at least two previous failures) were identified and included in this study. For each patient, age, gender, body mass index (BMI), previous abdominal operations and hernia repairs, American Society of Anesthesiologists (ASA) score, type and size of mesh, operating time, operative blood loss, length of hospitalization, complications, hernia recurrences, and time of followup were recorded. Followup assessment of hernia recurrence was performed based on a physical examination, abdominal imaging, or a telephone interview (modified from the validated questionnaire) conducted as part of a routine followup. Patients who expressed any concerns about their repair or had any reported abdominal discomfort during a telephone followup were reevaluated in the office and often reimaged.

Operative details
All patients received a mechanical bowel preparation before their operation; oral antibiotics were not used routinely. A first-generation cephalosporin or vancomycin was given preoperatively, and the cephalosporin was repeated if the operation lasted longer than 2 hours. A midline incision with excision of old scar(s) was used in the majority of patients. Dissection was then carried out through the subcutaneous fat, and the peritoneal cavity was entered. If panniculectomy was planned, the transverse elliptical/inverse-T incision was made in the lower or midabdomen by the plastic surgery team; standard operative procedure also included elevation of skin flaps to the costal margin. The peritoneal cavity was then entered through the hernia sac or linea alba. Adhesiolysis was performed with caution to avoid bowel injury. Serosal tears or small enterotomies without spillage were repaired with interrupted silk stitches. Old mesh, if present, was routinely removed.

Once adhesiolysis was completed, a preperitoneal plane was entered, and peritoneal flaps were developed circumferentially. The preperitoneal space was typically developed to the pubis and bilateral Cooper’s ligaments inferiorly, the lateral edge of the psoas muscles laterally, and to the level of the diaphragm and xiphoid process superiorly. Creation of the preperitoneal plane may be very difficult. We typically enter the space of Retzius at the lower midline level. Then, using a blunt finger dissection, the plane is developed deep into the pelvis, exposing the pubis and both Cooper’s ligaments. Laterally, the peritoneal flap is developed toward the lateral edges of the psoas muscles and then cephalad. Finally, the dissection plane is developed back toward the midline. The majority of this dissection is performed bluntly, using a surgeon’s hand. If the hernia is located in the parailiac area, the dissection continues laterally to a point just anterior to the psoas muscle behind the ureter.

When this dissection is complete, the peritoneum is reapproximated with a running absorbable suture to completely cover exposed abdominal viscera. Fenestrations in the peritoneum are closed primarily or “patched” with tongues of omentum, remnants of the
hernia sac, or both. Polypropylene mesh is placed between the peritoneum and fascia, extending circumferentially to allow at least 7 cm of mesh-to-defect overlap, whenever possible. Because the majority of patients in this series had massive hernias, mesh reinforcement spanned essentially the entire abdominal wall. To secure the mesh in place, it was first anchored with interrupted nonabsorbable sutures at the pubis and Cooper’s ligaments. Full thickness, transabdominal, permanent sutures incorporating the mesh were then placed inferior-laterally, laterally, and along the costal margin every 4 to 6 cm. Superiorly, the mesh was fixed in place with a transabdominal suture on each side of the xiphoid process. The sutures were passed through the abdominal wall using a curved (Reverdin) needle, and the knots were tied down in the subcutaneous tissue. In the rare instance that the preperitoneal plane could not be dissected free, the mesh was placed in the retrorectus space anterior to the posterior rectus fascia. Closed suction drains were always placed above the prosthetic and kept in place until a daily output was approximately 30 mL or less, but no longer than 5 to 7 days. The midline fascia was closed when possible. Abdominoplasty (if necessary) was then completed by the plastic surgeon. Nasogastric tubes were not used routinely. Postoperative care included epidural or intravenous pain management, aggressive early mobilization, and diet advancement according to the amount of dissection performed or commencing with the return of bowel function.

RESULTS
During the 4.5-year period of this study, 128 patients who had at least 2 previously unsuccessful repairs were evaluated for symptomatic, recurrent ventral hernias. Thirty-two (25%) patients deemed not to be candidates for a laparoscopic approach and had undergone open preperitoneal retrofascial repair were included in this study. Twenty-nine patients were operated on electively, and the other three patients underwent urgent repairs because of escalating symptoms. There were no emergent repairs. There were 28 (87.5%) women, with an average age of 49.8 ± 11.8 years (SD; range 36 to 73 years). The average BMI was 39.1 ± 8.4 kg/m² (SD; range 28.9 to 61.0 kg/m²), and 22 (68.8%) patients were morbidly obese (BMI > 35 kg/m²). The average American Society of Anesthesiologists score was 2.2 (range 2 to 4). Significant comorbidities included cardiac disease in 12 (38%), pulmonary disease in 11 (34%), diabetes mellitus in 13 (41%), steroid use in 5 (16%), and cigarette smoking in 6 (19%) patients. The average number of previous hernia repairs was 3.6 (range 2 to 24 repairs). The distribution of the number of previous hernia repairs is summarized in Figure 2.

Chronically incarcerated bowel was discovered in 12 (37.5%) patients. Twenty-seven (84.4%) patients had predominantly a midline defect. The average operative time was 221 ± 70 minutes (SD; range 76 to 351 minutes) with a mean blood loss of 176 mL (range 50 to 550 mL). Polypropylene mesh was used in all patients, including lightweight polypropylene mesh (Ultrapro; Ethicon, Inc) in 10 (31.2%) patients. The average mesh size was 937 ± 531 cm² (SD; range 225 to 1,800 cm²). Fourteen (43.8%) patients underwent an abdominoplasty at the time of herniorrhaphy. One patient had a small bowel enterotomy without spillage; it was repaired and the hernia repair was completed. There were no major intraoperative complications.

Postoperatively, 6 patients (18.8%) developed 9 complications, including 2 cases of atelectasis/pneumonia, 1 urinary tract infection, 1 case of deep vein thrombosis, and 1 case of transient acute renal failure. Wound/mesh infection occurred in 4 patients (12.5%). The type of antibiotic prophylaxis or a history of previous wound infection was not a significant risk factor in the development of wound morbidity. One patient had wound cellulitis, which resolved after a brief course of antibiotics. Antibiotics and percutaneous drainage were used in another three patients. This strategy was successful in one patient. Two remaining patients required operative debridement, with subsequent need for partial mesh excision in one of these patients. All four patients with wound-related morbidity were smokers.
Overall, 4 of 6 smokers (67%) had wound complications. Cigarette smoking was the only significant (p = 0.0004) predictor of postoperative wound/mesh-related morbidity. There were no perioperative mortalities. The average length of hospitalization was 5.7 ± 2.7 days (SD; range 2 to 13 days). At a mean followup of 28.1 months (range 8 to 60 months), there has been 1 (3.1%) recurrence in a patient requiring partial mesh removal.

**DISCUSSION**

Ventral and incisional hernia repair remains a challenging part of the practice of general surgery. Complication and recurrence rates of 20% or greater\textsuperscript{1,10,20,22,23} have pressed surgeons over the last 2 decades to examine the methods by which these defects are approached. In addition, industry has joined the push to affect outcomes, resulting in the development of an ever-expanding repertoire of new techniques and new meshes.

Laparoscopic ventral hernia repair has been widely popularized by many investigators, including our group.\textsuperscript{3,24-29} In fact, the laparoscopic approach remains preferable in the majority of our patients.\textsuperscript{5,19,30} We have found that minimally invasive techniques can be effectively applied to complex hernias in difficult patients.\textsuperscript{19,30} Despite growing experience, laparoscopy may be difficult in some patients with previous intraabdominal catastrophes, loss of domain, large pieces of previously placed mesh that require resection, complex hernias in unusual locations, and abdominal skin grafts or very thin skin with its vasculature being derived from the intraabdominal viscera. In addition, patients who need panniculectomy to remove thin or compromised skin, multiple scars, poorly vascularized underlying tissue, or to reduce the encumbrance of an extremely large pannus are candidates for an open herniorrhaphy. Patient preference also plays a role, especially in patients referred after a previously unsuccessful laparoscopic herniorrhaphy. In these patients, open preperitoneal mesh herniorrhaphy is an effective technique. This study reviews our experience with this method of repair in patients with multiply recurrent hernias.

Since its introduction in 1989,\textsuperscript{13} the Rives-Stoppa technique has been popularized by many surgeons and recently was proclaimed to be the gold standard for open mesh hernia repairs by the American Hernia Society. Recurrence rates with this technique have been reported to be 1% to 14%.\textsuperscript{10,13-16,18} The advantages of a large mesh with significant overlap placed under the muscular abdominal wall can possibly be explained by Pascal’s Principles of Hydrostatics. The intraabdominal cavity functions as a cylinder, so pressures are distributed uniformly to all aspects of the system. The same forces that are attempting to push the mesh through hernia defects are also holding it in place against the adjacent intact abdominal wall. The technique described in this article closely resembles that described by Stoppa, but the mesh is placed between the posterior rectus fascia and the peritoneum instead of between the posterior rectus fascia and the rectus muscle. Although developing this preperitoneal plane can be challenging when the abdomen has been violated repeatedly, it can usually be dissected sufficiently to fully protect the underlying bowel from the mesh.

We chose this technique for three reasons: it allows mesh overlap of the defect of 8 to 10 cm or more; it allows for a quick and full dissection deep into the pelvis and space of Retzius to the pubis; and the preperitoneal plane is usually a bloodless dissection, which eliminates the risk of injury to the epigastric and perforating vessels, leading to rectus muscle devascularization, in a frequently compromised abdominal wall. The prefascial mesh placement as described by Stoppa is limited by the lateral borders of the rectus sheath. Dissection in the preperitoneal plane allows the surgeon to position and safely secure the mesh to the pubis and Cooper’s ligaments (reinforcing both myopsectineal triangles), overlaying the wings of the iliac bones, posterior-laterally to the psoas muscles, and beyond the costal margins superiorly. Wide mesh deployment beyond the hernia defects and full-thickness transabdominal circumferential suture fixation ensures adequate mesh overlap, reduces the chance of mesh migration, and aids in eliminating recurrence. Indeed, if the mesh remains where it is placed, the recurrence rate with this technique should be zero. To that end, only one recurrence was noted in our study and this was in a patient requiring mesh resection because of infection.

Major open abdominal wall repairs in patients undergoing massive herniorrhaphy carry a relatively high perioperative risk.\textsuperscript{31-33} The fact that we were able to avoid significant morbidity in our series may be partially because of a thorough preoperative assessment and multidisciplinary approach. Many of our patients underwent complete cardiopulmonary clearance, including cardiac stress testing, pulmonary function testing, and, occasionally, sleep studies. Most undergo a preoperative ab-
dominal CT to evaluate the size and location of the hernia defect(s) and the organs involved. A preoperative screening colonoscopy is often performed in patients more than 50 years old. We also offer preoperative weight loss counseling or, given the patients’ motivations, a gastric bypass in morbidly obese patients. Abdominoplasty has also become an important adjunct to our approach to hernia repair in many of these patients. The addition of abdominoplasty to ventral herniorrhaphy in morbidly obese patients has been shown to result in a low recurrence rate with a modest wound-related morbidity.34-36

A strong working relationship with the Department of Plastic Surgery has allowed a team effort to aggressively manage these patients who have traditionally had a substantial risk of perioperative morbidity. An extensive transverse resection of a large pannus or extensive scarring of the abdominal wall during hernia repair may minimize postoperative wound-related morbidity. In this series, only 2 of 14 (14%) patients who underwent a concomitant abdominoplasty with hernia repair had wound-related complications despite having more formidable abdominal scarring or a large pannus and typically requiring a more extensive operation.

Infectious complications of surgical procedures can have devastating consequences. Infections of the implanted mesh prosthetics can be especially difficult to treat and can lead to mesh resection and hernia recurrence. So strategies to avoid such infections are important adjuncts to the procedures that involve mesh implantation. Antibiotic prophylaxis is administered at least 30 minutes before incision to optimize tissue concentrations. Intraoperatively, we usually redose prophylactic antibiotics, depending on their half-life, if a procedure lasts longer than 2 to 3 hours. We also routinely use an Ioban (3M) drape to avoid mesh contact with skin. It has also become our policy to push patients to stop or significantly decrease cigarette smoking before elective surgery to decrease risks of wound infection.37 Not surprisingly, all of our wound-related morbidity occurred in tobacco smokers; two-thirds of smokers developed wound or mesh complications. If a wound or a mesh becomes infected, conservative management strategies are used first. Antibiotics and percutaneous drain placement for intraabdominal or deep subcutaneous collections are standard. Local wound explorations, when needed, are performed in the operating room. We have found that areas of exposed polypropylene may be effectively treated with local wound care and vacuum-assisted devices. These strategies were effective in mesh salvage in 3 of 4 (75%) of our patients with wound or mesh infections.

The search for a prosthetic mesh best suited for open ventral herniorrhaphy is ongoing. A wide variety of meshes consisting of polypropylene, polyester, and expanded polytetrafluoroethylene are available to surgeons today. Because our technique does not involve exposure of abdominal viscera to the mesh, we typically do not use composite meshes, which are designed for intraperitoneal use. Earlier in our experience, standard polypropylene (Prolene Mesh, Ethicon, Inc; Marlex Mesh, CR Bard, Inc) mesh was our prosthetic of choice. More recently, our laboratory investigations38,39 and human experiments have indicated that these formulations of "heavyweight" polypropylene mesh may have been "overengineered" and are much stronger than physiologically necessary to repair a hernia.40-42 Available data demonstrate that maximal intraabdominal pressures generated by healthy volunteers undergoing various physical activities range between 64 and 141 mmHg.38 Although the burst strength of a lightweight mesh is significantly lower than that of the traditional heavyweight polypropylene meshes (576 Newtons versus 1,200 Newtons, respectively, p < 0.001),39 its burst strength is still more than double that of the native fascia (232 Newtons).39

It has been demonstrated that traditional or heavyweight prosthetics become stiff and noncompliant because of the significant inflammatory response; lightweight biomaterials remain more closely matched with the natural physiologic distensibility (compliance) of the abdominal wall.39,43-46 As a result, we have abandoned the use of traditional polypropylene (manufactured at 95 to 110 g/m² of polypropylene content) meshes in favor of the reduced or lightweight polypropylene products (manufactured at 28 to 35 g/m²). Animal experiments validate that the diminished foreign body reaction to the lightweight meshes results in improved preservation of the pliability of the prosthetic and maintenance of the overall compliance of the mesh/native tissue complex.41,46,47 Emerging clinical data also show that the use of macroporous lightweight polypropylene mesh results in decreased chronic discomfort and a reduced restriction of physical activities while providing more than adequate strength for reinforcement of tension-free hernia repairs.38,40,48-51
ducting a prospective objective assessment of the impact of these newer biomaterials on our patients’ quality of life. Although early data are encouraging and we anticipate that lightweight meshes will be proved to allow for a durable longterm repair, will minimize chronic mesh-related discomfort, and will improve the overall quality of life of hernia patients, recommendations for their routine use are under ongoing investigation.

In conclusion, multiply recurrent ventral incisional hernias represent a challenging surgical problem. Open preperitoneal, retrofascial hernia mesh repair resulted in an effective herniorrhaphy with low perioperative morbidity, even in this series of challenging patients. Although wound or mesh infection occurred in 12.5% of patients, a combination of percutaneous drainage, vacuum-assisted closure devices, and operative debridement allowed for mesh salvage in 75% of these patients. Cigarette smoking was the only significant risk factor of wound- or mesh-related morbidity. Because all patients with wound or mesh complications were smokers, smoking cessation might be important in minimizing infectious complications. Abdominoplasty may be a significant adjunct to successful herniorrhaphy and reduction in infectious complications in morbidly obese patients with multiply recurrent hernias. Given the technical challenge, surgical care of patients with multiply recurrent hernias may be best provided in referral centers with interest and expertise in management of complex abdominal wall hernias.

**Author Contributions**

Study conception and design: Novitsky
Acquisition of data: Novitsky, Porter, Rucho
Analysis and interpretation of data: Novitsky, Pratt
Drafting of manuscript: Novitsky, Heniford, Kercher
Critical revision: Heniford, Kercher, Pratt, Getz

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