Reliable complex abdominal wall hernia repairs with a narrow, well-fixed retrorectus polypropylene mesh: A review of over 100 consecutive cases

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Background. *Our objective was to determine outcomes for complex ventral hernia repairs in a large cohort of patients utilizing an operative construct employing retrorectus placement of a narrow, macroporous polypropylene mesh with up to 45 suture fixation points for force distribution. No consensus exists on the optimal technique for repair of complex ventral hernias. Current trends emphasize large meshes with wide overlaps and minimal suture fixation, though reported complications and recurrence remain problematic.*

Methods. *A retrospective review was performed for all patients undergoing ventral hernia repair with retrorectus placement of midweight, uncoated, soft polypropylene mesh by a single surgeon (GAD) between the years of 2010 and 2015. Patient characteristics, operative history, operative data, and postoperative course were reviewed.*

Results. *A total of 101 patients with a mean age of 56 years and a mean body mass index of 29 m/kg^2 (range 18–51 m/kg^2) underwent hernia repair. Patients had a median of 3 prior abdominal operations (range 0–9), with 44 patients presenting with recurrent hernias. A total of 42 patients were Ventral Hernia Working Group grade 1, 40 grade 2, 17 grade 3, and 2 grade 4. There were no recurrences at a mean follow-up of almost 400 days for the 93 patients with long-term follow-up. The surgical site occurrence rate was 7.9% (3 surgical site infections, 2 seromas, 2 hematomas, and 4 instances of delayed wound healing in 8 patients). One patient required reoperation for hematoma drainage; 5 patients required readmission within 30 days.*

Conclusion. *An operative construct employing a retrorectus placement of a narrow, macroporous polypropylene mesh with up to 45 suture fixation points for force distribution can achieve significantly better outcomes across a spectrum of Ventral Hernia Working Group grade, risk-stratified patients compared to rates reported in the literature for current strategies that employ wide meshes with minimal fixation. (Surgery 2016;■:■-■.)*

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The "holy grail" of hernia repair is to achieve a lasting, high-tension, internal closure of the abdominal wall that is strong enough to withstand forces that lead to hernia recurrence and gentle enough to be performed with reliable healing. Unacceptable, high rates of early wound problems and late hernia formation indicate that such a procedure still has not been identified. High-level evidence has found a 32% 10-year recurrence rate for mesh repair of hernias <6 cm.[1]

Conceptually understanding the basis of hernia formation is essential to designing and executing a successful repair. Simply stated, forces placed on the abdominal wall must not exceed the strength of the repair. In a sutured repair, tension is borne at the suture/tissue interface (STI), with this force being distributed among the number of points at which suture and tissue meet. Acute dehiscence

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results when early tension on the repair exceeds the combined physical strength of the STIs and the strength of biologic healing. In contrast, incisional hernia formation results from chronic suture pull-through, or "cheese wiring," of the tissue over time. As forces at the STI exceed the perfusion pressure of the tissue held within the loop of the suture, this tissue turns to scar, which in turn remodels in response to the pressure of the suture and is weaker than the native abdominal wall.[2]

Both acute dehiscence and late incisional hernia formation are linked by the concept of "gap formation." Playforth,[3] in 1986, demonstrated that separation of radiopaque, fascial markers >10 mm at early time points after abdominal wall closure was predictive of future incisional hernia formation. This work was recently confirmed in a murine hernia model.[4] Incisional hernias likely begin as a subclinical acute dehiscence in the form of gap formation between the opposed midline fascial edges. Limiting suture pull-through by utilizing an initial physical construct that is stronger than the early forces applied is the key to solving the hernia repair problem.

With these considerations in mind, we emphasize in this series a technique for ventral hernia repair that minimizes suture pull-through and gap formation by distributing the forces for closure across a narrow macroporous polypropylene mesh with up to 45 transrectus sutures while still respecting soft tissue perfusion. Our central precept is that it is not just the use of mesh but how the mesh is utilized that is critical to preventing recurrence, thereby reducing individual patient factors such as obesity to relative unimportance. As will be seen, this procedure is the direct antithesis of the transversus abdominus release that utilizes a giant prosthetic mesh with minimal to no suture fixation. We report on both early complications and late patient tolerance in terms of function and pain for the procedure in 101 consecutive patients.

METHODS

A comprehensive, retrospective review was performed for a consecutive series of patients undergoing ventral hernia repair with a retrorectus placement of midweight, uncoated polypropylene mesh (PROLENE Soft Prolene Mesh; Ethicon, Somerville, NJ) by a single surgeon (GAD) at Northwestern Memorial Hospital between the years of 2010 and 2015. Data on patient characteristics and operative history were obtained, and patients were stratified according to the Ventral Hernia Working Group classification.[5] Computed tomography (CT) scans were reviewed when available, and hernia dimensions were recorded. Using the digital radiology system measurement tools, the widest separation of the medial aspect of the rectus muscles was recorded, as was the craniocaudal dimension of the hernia (Figure 1). The medical record was reviewed for the occurrence of both operative and medical, postoperative complications.

Operative complications reviewed included surgical site infection (SSI), seroma, dehiscence, development of enterocutaneous fistula, delayed wound healing requiring dressing changes, reoperation, readmission within 30 days, and hernia recurrence. SSI was defined as a clinical diagnosis of wound infection by the senior surgeon (GAD) based on the appearance of wound erythema, drainage, or need to open an incision due to concern for infection. Seroma was defined as any appreciable subcutaneous fluid collection in the postoperative period. Surgical site occurrence (SSO) was defined as any occurrence of superficial or deep SSI, seroma, hematoma, delayed wound healing, enterocutaneous fistula, or dehiscence. All medical complications requiring an intervention (eg, antibiotics for pneumonia) were counted.

Long-term SSOs were defined as hernia, fistula, or need for removal of mesh with clinical information at least 3 months after the operation. Hernia recurrence was assessed in 4 distinct ways: (1) physical examination by the senior author or abdominal/pelvis CT scan, (2) patient reported outcome of hernia recurrence, (3) documented abdominal examination by any Northwestern physician, and (4) longest documented abdominal examination of any type since the operation.

A validated pain survey (Patient-Reported Outcome Measurement Information System [PROMIS]) was administered to patients to measure the effect of hernia repair on their daily pain levels, with a supplemental question added to assess pre- and postoperative employment status. Patients were contacted initially by telephone, followed by an e-mail providing a link to an electronic survey. Certified mail was used to survey patients who did not use e-mail. Certain patients completed the survey in person when returning for routine follow-up visits. Patients who could not be reached on the first attempt received a follow-up call and e-mail, and finally a phone call by the senior author in order to increase response rate.

Statistical analysis. Descriptive statistics were obtained using a spreadsheet (Excel; Microsoft Corporation, Redmond, WA). Analysis of PROMIS results was performed using SAS software, version 9.4 (SAS Institute, Cary, NC). Statistical difference between means was determined utilizing the

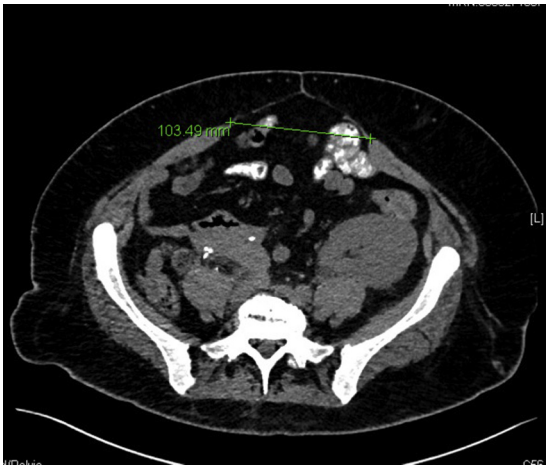

Fig 1. Preoperative CT scan of ventral hernia. Preoperative CT scan of a representative patient in our series showing a large ventral hernia measuring 10 cm in transverse dimension. The bilateral rectus complexes have migrated laterally from the midline with retraction of the oblique musculature visible. (Color version of this figure is available online.)

Student *t* test. The problem of multiplicity was remedied using a Bonferroni correction, where statistical significance was defined as $\alpha = 0.05/3 = 0.016$.

Operative technique. Patients were given a single dose of preoperative antibiotics, 2 g of cefazolin or 900 mg of clindamycin for patients with a penicillin allergy, within 1 hour of operative incision. The abdomen was accessed through the prior vertical midline incision when present, or through a new vertical midline incision, often extending from the level of the xiphoid to the level of the pubic symphysis. After entering the abdominal cavity and performing any necessary lysis of adhesions, the hernia sac was dissected free from surrounding soft tissue and removed entirely (Fig 2, *A*). The soft tissue was elevated 4 cm off the unscarred anterior rectus fascia. The retrorectus space was then developed with electrosurgical dissection between the posterior rectus sheath and the overlying rectus muscle, also for 4 cm, to allow for situation of the mesh and suture placement (Fig 2, *B*).

Attenuation of the linea alba and functionally significant rectus diastasis often necessitates extending the retrorectus repair well cranial and caudal to the original vertical components of the fascial defect to achieve a strong midline construct. The inferior epigastric artery and any segmental nerves were preserved when visualized. In cases in which the posterior sheath could not be easily approximated in the midline, an anterior component separation of the external oblique aponeurosis was performed using a perforator-sparing technique, as previously described.[6] The posterior rectus sheath was then closed using a running 2-0 polydiaxanone suture (Fig 2, *C*).

Uncoated midweight polypropylene mesh with a length sufficient to span from the xiphoid process to the pubic symphysis was then brought into the operative field and cut to a transverse width of 7.5 cm (PROLENE Soft Polypropylene Mesh; Ethicon). The mesh was then trimmed to the vertical dimension of the retrorectus dissection and inset using interrupted 0-polypropylene sutures taken as full-thickness bites of anterior rectus sheath and rectus muscle 4 cm from the medial edge of the rectus. A small bite of the mesh was taken and the needle passed back through the rectus muscle and anterior sheath. Sutures were placed at roughly 2–3 cm increments along the entire length of the rectus complex bilaterally (Fig 2, *D*). The first several sutures placed, starting superiorly at the apex, were tagged with hemostats and not tied immediately.

Once approximately 4 sutures on each side are placed, it can be determined whether the mesh is appropriately tensioned (ie, taught, flat, and with no wrinkles). Once this was assured, sutures were tied down, leaving the most inferior few tagged with a hemostat so that this process could be repeated for the entire length of the mesh to ensure that the mesh was inset in a flat, wrinkle-free manner. Placement of the mesh initially feels too tight, but after inset of the edges of the entire mesh, the rectus muscles with the attached overlying anterior rectus sheath fall together and are reapproximated in the midline to further distribute the forces with interrupted 0-polypropylene figure-of-eight sutures (Fig 2, *E*). Including the mesh fixation sutures and the midline closure, the total number of sutures is approximately 40–45 for a full midline closure.

At this point, redundant soft tissue at the midline often was excised as a vertical panniculectomy (Fig 2, *F*). The midline soft tissues are then closed in layers. The patient pictured in Fig 2 had a prior depressed C-section scar that needed excision; thus, a lower horizontal incision was also utilized when trimming redundant soft tissue and skin. Two closed suction drains were placed in the subcutaneous midline when no component separation was performed. When a component separation was necessary, one drain was placed in each lateral gutter and a single drain was placed in the subcutaneous midline. No drain was typically placed adjacent to the mesh.

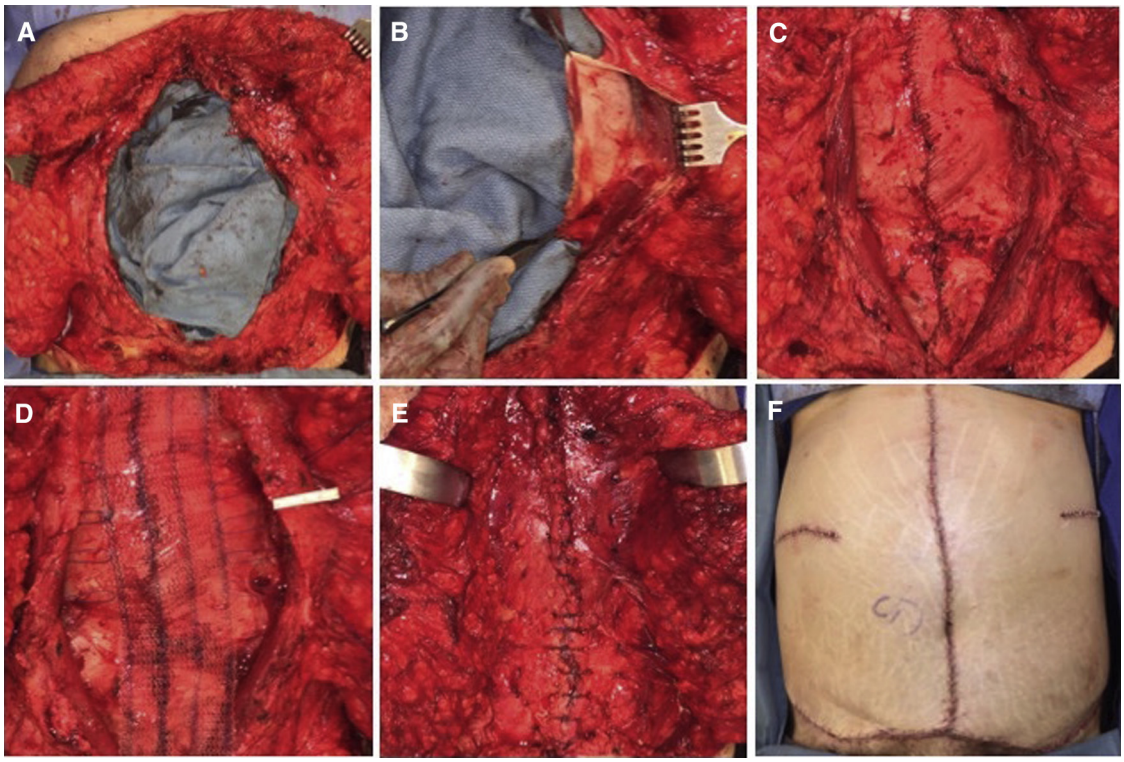

Fig 2. Retrorectus ventral hernia repair utilizing midweight polypropylene mesh and components separation. (*A*) The abdomen is accessed through the prior vertical midline incision, when present, or through a new vertical midline incision. Lysis of adhesions is performed as necessary, and the hernia sac is removed. The anterior rectus sheath is cleared of soft tissue for approximately 4 cm from its medial edge bilaterally to allow for suture placement. (*B*) The retrorectus space is developed; separation of the posterior rectus sheath from the rectus muscle. (*C*) The posterior rectus sheath is closed using a running 2-0 polydiaxanone suture. (*D*) Uncoated, midweight polypropylene mesh with a length sufficient to span from the xiphoid process to the pubic symphysis is cut to a transverse width of 7.5 cm. The mesh is inset using interrupted 0-polypropylene sutures taken as full-thickness bites of anterior rectus sheath and rectus muscle 4 cm from the medial edge of the rectus, ensuring that it is taught and flat without wrinkles. (*E*) The anterior rectus sheath is closed with interrupted 0-polypropylene figure-of-eight sutures (*F*) Redundant soft tissue at the midline is excised as a vertical panniculectomy and a layered closure of the abdominal soft tissues is performed. (Color version of this figure is available online.)

RESULTS

A total of 101 patients were included in our series. Patient demographics and comorbidities are displayed in Table I. Average patient age was 55.7 years. Roughly one third were male and two thirds female. The mean body mass index was 29.1, although over one third of the patients were obese with 15 patients being morbidly obese. Mean American Society of Anesthesiologists score was 2.2. Only 1 patient had a history of chronic obstructive pulmonary disease, whereas 10 patients were diabetic and 7 were current or recent smokers (within 3 months of the operation). For the patients with preoperative CT scans, the average transverse fascial defect was 6.2 ± 3.6 cm (range 1.2–19.7 cm) and average craniocaudal fascial defect was 7.5 ± 5.0 cm (range 0.8–20.6 cm) for a mean defect area of 46.7 cm^2. For patients who underwent component separation, the average transverse fascial defect was 7.9 ± 4.0 cm (range 2.0–19.7 cm) and average craniocaudal fascial defect was 10.2 ± 5.8 cm (range 1.5–20.6 cm) for a mean defect area of 80.6 cm^2.

Patients had an average of 2.9 prior abdominal operations, with a range as high as 9 (Table II). Forty-four percent of patients had recurrent hernias, with a range of 1–4 prior hernia repairs performed by other surgeons. Close to one third of patients had a prior mesh repair, 10 had a prior biologic repair, and the remainder had unsupported suture repairs. Only 6 patients had prior components separations performed. Fifteen patients had a history of prior mesh or wound infection. Classification by Ventral Hernia Working

Table I. Patient demographics and comorbidities

Characteristic	*Value*
Age at time of operation (mean ± SD)	55.7 (12.0)
Men (no. of patients)	34
Women (no. of patients)	67
BMI (mean ± SD)	29.1 (6.2)
COPD	1 (1.0%)
Diabetic	10 (9.9%)
Current/recent smoker	7 (6.9%)
Recent chemotherapy	6 (6.0%)
Immunosuppressant drugs	8 (7.9%)
ASA score (mean ± SD)	2.2 (0.56)
BMI <24.9 (no. of patients)	22
BMI 25–29.9	43
BMI 30–34.9	21
BMI 35–39.9	8
BMI >40	6
BMI >50	1

SD, Standard deviation; *BMI*, body mass index; *COPD*, chronic obstructive pulmonary disease; *ASA*, American Society of Anesthesiologists.

Table II. Operative history

Characteristic	*Value*
No. of prior abdominal operations, mean ± SD (range)	2.9 ± 1.9 (0–9)
No. of patients with recurrent hernia	44 (43.6%)
No. of prior ventral hernia repairs	
1	24 (23.8%)
2	12 (11.9%)
3	4 (4.0%)
4	3 (3.0%)
Prior mesh repair	29 (28.7%)
Prior biologic repair	10 (9.0%)
Prior components separation	6 (5.9%)
Prior mesh or wound infection	15 (14.9%)

SD, Standard deviation.

Group score yielded 42 (41.6%) grade 1, 40 (39.6%) grade 2, 17 (16.8%) grade 3, and 2 (2%) grade 4 patients. Thus, over half of the patients were VHWG grade 2 or above.

Thirty-nine patients had concomitant procedures performed, including 25 who underwent abdominoplasty, 5 who underwent liposuction, and 9 who underwent a variety of nonabdominal procedures. Total mean operative time was 153 ± 44 minutes overall, 135 ± 44 minutes for hernia repairs without a concomitant procedure performed (Table III). Twenty-eight patients underwent components separation.

Outcomes are displayed in Table IV. The overall rate of SSO was 7.9%. Three patients developed an SSI and two developed a seroma. Two patients developed a postoperative hematoma, one of which required a return to the operating room. Four patients experienced delayed wound healing requiring dressing changes. Four patients experienced a medical complication: 2 developed a urinary tract infection, 1 developed postoperative pneumonia, and 1 developed atrial fibrillation and a pulmonary embolus that was treated with anticoagulation. Patients stayed in the hospital for a median of 5 nights (mean 4.7 ± 1.5 nights) after operation while awaiting return of bowel function. Readmission rate was 5%: 2 patients were readmitted for a small bowel obstruction, 1 for pneumonia, 1 for a pulmonary embolus, and 1 for intravenous antibiotics for an SSI. A median of 2 postoperative visits were required in the first 90 days.

To our knowledge, none of the 101 patients in this series have had a hernia recurrence, fistula, or mesh extrusion, although 8 patients were not seen more than 3 months after the operation and were excluded from further analysis. A total of 93 patients were seen by the senior author or had a CT scan showing their abdominal repair to be intact 399 days on average after the operation; 59 patients self-reported being hernia free 579 days on average after the operation. For all Northwestern physicians (including the senior author) who recorded an abdominal exam, the average hernia-free duration was 689 days. Finally, using follow-up from either patient or physician for these 93 patients, hernia-free time after the operation averaged 775 days (range 186–2,116 days).

A total of 59 patients completed PROMIS assessments for a response rate of 58%. Patients were an average of 1.6 years out from the operation at the time of survey response (range 156 days to 4.5 years). PROMIS data stratified by sex are displayed in Table V. PROMIS scoring ranges from 30 (no pain) to 100 (debilitating pain) and is constructed such that when administered to the general population, the average T-score for outcome measures is 50 with a standard deviation of 10.[7,8] Thus, postoperative ventral hernia repair patients in our cohort displayed pain interference, intensity, and behavior scores, as well as global physical and mental health scores, commensurate with that of the general population.

In particular, the average postoperative pain intensity score of our patients was 37.8 ± 7.5 for women and 37.6 ± 9.1 for men, indicating a pain intensity substantially below that of the general population and approaching the lower, pain-free end of the PROMIS scale. As an additional point of reference, the average pain intensity score for

Table III. Operative characteristics

Characteristic	*Value*
Presence of ostomy at time of operation	2 (2.0%)
Presence of open wound at time of operation	2 (2.0%)
CDC I clean wound	96 (95.0%)
CDC II clean-contaminated wound	4 (4.0%)
CDC III contaminated	1 (1.0%)
Total operative time (min, mean ± SD)	153.2 ± 44
Concomitant abdominoplasty	25 (24.8%)
Concomitant liposuction	5 (5.0%)
Other concomitant procedure	9 (8.9%)
Components separation	28 (27.7%)

CDC, Centers for Disease Control and Prevention; *SD*, standard deviation.

Table IV. Operative outcomes

Outcome	*Value*
SSO	8 (7.9%)
SSI	3 (2.9%)
Hematoma	2 (2.0%)
Seroma	2 (2.0%)
Dehiscence	0 (0%)
Enterocutaneous fistula	0 (0%)
Delayed wound healing	4 (4.0%)
Reoperation	1 (1.0%)
Readmission	5 (5.0%)
Recurrence	0 (0%)
Average inpatient admission, nights, mean ± SD (range)	4.7 ± 1.5 (1–9)
Median no. of POV in 90 days	2
Average follow-up by senior author (d)	399
Average follow-up all types (d)	775
Range of follow-up (d)	186–2,116

SD, Standard deviation; *POV*, post operative visit.

patients recruited from the American Chronic Pain Association for PROMIS validation was 68.2 ± 4.9. The maximum pain intensity scores reported for our patients were 60.5 for women and 57.5 for men. As a rule, patients repaired with our technique are functioning on par with their healthy peers and are experiencing a low level of pain. Only 3 patients (5.1%) report being unable to work, with the remainder being either employed, currently seeking employment, or retired.

We also compared PROMIS results for our postoperative patient cohort to a historical data set of PROMIS score for preoperative hernia patients, showing statistically significant lower pains scores after hernia repair. This cohort had a preoperative profile similar to the current cohort: mean age of 54 years, mean body mass index of 31, 45% women, all with incisional hernias, 35% presenting with recurrent hernias, with an average of 2.1 prior abdominal operations, and a similar comorbidity profile.

Pain behavior T-scores were 6.5 points lower for the postoperative patient cohort (51.1 vs 44.6, $P = .0012$, 95% confidence interval [CI] = −10.33 to −2.61); pain interference T-scores were 6.2 points lower for the postoperative patient cohort (53.8 vs 47.6, $P = .0005$, 95% CI = −9.71 to −2.78); and pain intensity scores were 3.1 points lower for the postoperative patient cohort (4.4 vs 1.3, $P < .0001$, 95% CI = −3.91 to −2.23). Pain intensity was compared on a 10-point scale, as the newer 30–100 point pain intensity scoring system was not introduced until after PROMIS data were collected for the historical cohort.

DISCUSSION

Lack of consensus on the optimal ventral hernia repair technique stems in part from the fact that there is no "common start point" for hernia patients: They vary with respect to age, comorbidities, body habitus, number and type of prior abdominal incisions and attempted hernia repairs, and size and location of the hernia defect. Perhaps as a result of this patient heterogeneity, the overarching theme of the hernia literature has been a paradigm that focuses on patient factors, rather than technique of abdominal wall repair, as the root cause of SSO and recurrence.

It is clear that mesh-reinforced repairs of ventral and incisional hernias have lower recurrence rates, though less clear is the size of mesh needed and the optimal manner of fixation. We utilize a narrow (7.5 cm) strip of mesh that, in most cases, spans from the xiphoid cranially to the pubic symphysis caudally. This is a far narrower mesh than is commonly described for incisional hernia repair. Assuming a mean xipho-pubic distance of 30 cm, we use 225 cm^2 of mesh in an average patient. For a full midline repair, this mesh is inset as a high-tension, taught construct utilizing 40–45 points of suture fixation. Use of a macroporous mesh (pore size >1 mm) ensures incorporation, minimizes fibrosis that can lead to poor abdominal wall compliance and pain, and is associated with less wrinkling and shrinkage.[9-11] We orient the blue lines of the mesh in a craniocaudal direction to maintain its effective porosity under lateral tension.

Table V. PROMIS

Sex	*Number of patients*	*PROMIS measure*	*PROMIS score, mean ± SD (range)*
Female	44	Pain behavior	44.9 ± 10.8 (34.1–63.7)
		Pain interference	47.4 ± 7.9 (40.7–67.7)
		Pain intensity	37.8 ± 7.5 (30.7–60.5)
		Global physical health	52.9 ± 8.8 (34.9–67.7)
		Global mental health	53.2 ± 9.3 (33.8–67.6)
Male	15	Pain behavior	43.7 ± 12.1 (34.1–64.5)
		Pain interference	48.2 ± 11.0 (40.7–67.7)
		Pain intensity	37.6 ± 9.07 (30.7–57.5)
		Global physical health	51.2 ± 11.0 (32.4–67.7)
		Global mental health	54.8 ± 10.0 (36.3–67.6)

A "high tension construct" offers multiple benefits. Ensuring the mesh is taught when inset prevents wrinkling, and utilizing many points of fixation ensures a low tension per suture despite the entire construct being under high tension. This is critical, as early suture pull-through, or "gap formation," is the key mechanism by which abdominal wall hernias form. Importantly, the mesh underlay acts as a pledget for the repair, offloading force borne by the native abdominal wall tissue at the suture–tissue interface during early stages of healing. Thus, this may more accurately be referred to as a suture–tissue–mesh interface, a critical difference between our technique and unsupported or bridged repairs.

The high-tension anterior closure protects the relatively weak and tight posterior fascial suture line. We do not incorporate hernia sac into the repair as this tissue consists of weak avascular scar tissue with less suture hold. Furthermore, a taught, well-fixated mesh likely decreases the risk of seroma formation and infection. A key orthopedic tenant of fracture fixation is that a well-fixated implant does not become infected. We believe this same principle applies to mesh implants in the abdominal wall. Friction from motion of the mesh can lead to seroma formation and poor incorporation, thus predisposing to infection. Use of a narrow strip of mesh leaves the lateral aspect of the abdominal wall compliant, allowing it to bend with movement, and improves patient tolerance of the mesh. In contrast, a large sheet of mesh inevitably wrinkles in attempts to conform to the cylindrical shape of the abdominal wall.

The concept we are advocating, that of a narrow mesh pulled taught and well fixated at 40–45 points to create a high-tension hernia repair, is diametrically opposed to the concept of use of a large mesh with wide underlay and minimal fixation, introduced by Stoppa and employed in modified form by Cobb et al,[12] Novitsky et al,[13] Krpata et al,[14] and others in recent trends in the literature. The latter technique is often combined with release of the transversus abdominis muscle to access a potential space for a large mesh underlay with wide fascial overlap. The amount of mesh used by these authors, an average of 506 cm^2 for Cobb et al[12] and 930 cm^2 for Krpata et al,[14] is 2–4 times the amount of foreign material we utilize in our repairs. The authors additionally use fewer points of fixation with a technique that does not ensure the mesh is secured and taut, explicitly relying on tissue ingrowth to anchor the mesh. Sutures are not employed due to the difficulty in placing such a lateral suture and the concept that lateral sutures can snag a peripheral nerve and lead to pain.[15]

A large study using the Rives-Stoppa technique reported a chronic pain rate of 27%.[16] Critics of our technique may protest that greater fixation of the mesh translates to greater pain, although our data indicate that it is not the case. We do counsel patients to expect significant postoperative pain in the immediate postoperative period, and one important factor for a median 5-day inpatient hospitalization is to ensure adequate analgesia; however, it is important to distinguish early postoperative pain from chronic abdominal wall pain.

A benefit of using a narrow mesh is that the points of fixation are closer to the midline where intercostal nerves supplying the abdominal wall have branched to small nerve endings, and sutures placed under direct vision can easily avoid the segmental nerves. Ensnaring a sufficiently large nerve by a loop of suture leads to chronic pain with transabdominal suture placement, and our technique minimizes the chance of this occurring. This is supported by PROMIS data showing postoperative pain levels in our patients below that of the general population. Further benefits include superior compliance of native abdominal wall as compared to having a larger mesh that must

conform to the cylindrical curvature of the abdominal wall laterally.

We believe that use of larger meshes results in greater complications as a result of elevation of larger tissue planes with increased dead space and inevitably results in wrinkling of the mesh as it is bent by the curvature of the cylindrical abdominal wall. A narrow mesh avoids these problems and limits the amount of foreign material. Our data support this. We have had low overall complications across VHWG grades: 7% SSO with 2 SSIs, 2 seromas, 2 hematomas, and 3 instances of delayed wound healing. These numbers compare very favorably to those from proponents of large mesh, minimal fixation repairs. Krpata et al[14] report an SSO rate of 16% with 13% SSI and 5% recurrence at 15 months, whereas Cobb et al[12] report an overall SSO rate of 37% with 19.6% SSI and 16.9% recurrence at 19 months.

With respect to position of the mesh, the retrorectus space has several advantages on which most contributors to the literature agree. Closure of the posterior sheath underneath the mesh shields the mesh from contact with bowel, which minimizes the risk of enterocutaneous fistula, bowel adhesions, and complications upon need for relaparotomy.[17,18] In addition, the retrorectus space provides a well-vascularized bed to allow optimal incorporation of a macroporous mesh. In all patients in this series, an anterior components separation was adequate to achieve posterior rectus sheath closure. Finally, we stress the importance of soft tissue handling to minimize wound complications. We utilize techniques to spare periumbilical perforators to the abdominal wall to ensure good skin vascularity. Furthermore, any redundant or compromised skin is excised in the midline prior to closure.

A comprehensive critique of the VHWG position is beyond the scope of the current article. It is important to note that the VHWG grading system was constructed post hoc, and its predictive value has not been demonstrated prospectively.[6] The results of our current study call into question the VHWG grading system. Greater than 50% of our patient cohort consisted of VHWG grades 2–4 patients: 40% grade 2, 17% grade 3, and 2% grade 4 patients. Two infections in our series were in grade 2 patients and the third was in a grade 4 patient. All of these subcutaneous infections were managed with intravenous antibiotics alone or in conjunction with local wound care without infection of the mesh requiring revision or removal. Moreover, we did not experience any SSI in grade 3 patients in this series with the use of prosthetic mesh. Our data thus suggest that grades 2 and 3 patients are not at a particularly high risk of infection compared to grade 1 patients and that infections can be handled with conservative measures.

We believe that an important corollary of our results is that we should shift the pendulum more toward following key principles of operative technique and less toward an emphasis on the patient as the cause of operative failure. While patient comorbidities are certainly important to consider, our results indicate that they are less important than has been stressed in determining the outcome of hernia repair. More importantly, our outcomes data do not support the notion that operative decision-making for hernia patients inevitably involves a tradeoff between risks of infection and recurrence. This is a false dichotomy, one that fuels unnecessary operative "nihilism" about SSO and SSI with open hernia repair. It also continues to fuel the use of biologics in VHWG grade 2 or greater patients despite the fact that biologics are associated with significantly higher hernia recurrence rates and cost.[19]

Our study is limited, as are all of the current series on retrorectus repairs, by a lack of long-term follow-up, though patient information of all types averaged over 2 years from the operation. We agree that at least 5-year, and optimally 10-year, follow-up data are needed to understand the true incidence of hernia recurrence in our population. Furthermore, despite best attempts to reach all patients for participation in the PROMIS survey, roughly 40% of patients did not complete the survey, opening the results to potential nonresponse bias. Nonetheless, our data do show a low surgical site complication rate, no recurrences at 399 days of follow-up, and low postoperative pain levels with high degrees of function.

In conclusion, an operative construct employing a retrorectus placement of a narrow macroporous polypropylene mesh with up to 45 suture fixation points for force distribution can achieve significantly better outcomes across a spectrum of VHWG grade, risk-stratified patients as compared to rates reported in the literature for current strategies that employ wide meshes with minimal fixation. We suggest an increased focus on key operative principles for a durable repair and less emphasis on the patient as the cause of operative failure. Long-term follow-up will determine the ultimate durability of this technique, though results to date are encouraging and suggest that we can work toward a new paradigm to effectively treat these difficult patients.

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