Postoperative Flank Defects, Hernias, and Bulges: A Reliable Method for Repair

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Background: Although there is a high incidence of flank defects after lateral abdominal access, there is a paucity of large studies discussing this problem. Most studies express nihilism regarding their surgical management. The goal of this study was to describe the authors' conceptualization of flank defects, with a determination of the number of true hernias versus bulges, and outcomes of surgical repair in these patients.

Methods: The authors carried out a 13-year retrospective review of 31 consecutive flank defects repaired by the senior author (G.A.D.). Patients were treated with a 7.5-cm-wide macroporous polypropylene mesh and reapproximation of the abdominal wall to achieve a direct supported repair. There were 19 intraperitoneal placements and 12 placements between the external and internal oblique muscles or preperitoneal space. The prevalence of true hernia versus bulge at the time of repair was noted.

Results: There were no surgical-site infections. Two patients developed minor bulges at the prior hernia site: one of these was repaired with additional mesh, and the other one was observed. One small asymptomatic recurrent hernia was noted incidentally on a follow-up computed tomographic scan. Initially, 10 patients had a complete hernia through all layers of the lateral abdominal musculature, 17 patients had dehiscence of the internal oblique and transversus abdominis muscles with an intact external oblique muscle, and four patients had denervation with all layers of the abdominal wall intact.

Conclusions: Most flank defects represent true hernias rather than denervation injuries. Direct supported repair of flank hernias using mesh is a safe and effective technique. (*Plast. Reconstr. Surg.* 137: 994, 2016.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

A certain nihilism exists regarding bulges and hernias of the lateral abdominal wall, mainly because of controversy over the cause of these conditions. The classic explanation is that these are "denervation injuries," in which transection of the lower thoracic intercostal nerves leads to a weakening of the lateral abdominal wall.[1] Described reconstructions include wide meshes and large dissections to create additional scar and support.[2–4] The incidence of flank bulge after retroperitoneal access for urologic, vascular, and spine operations is fairly high, often cited as being between 8 and 23 percent,[1,5–7] but reaching as high as 50 to 57 percent in some reports.[8,9] These unsightly contour deformities of the lateral abdominal wall can be associated with significant pain and decreased quality of life.[8] Despite a growing number of reports describing postoperative flank bulges, their management has been regarded as a surgical challenge. Our experience is that a majority of defects in the lateral abdominal wall after flank incisions represent true hernias that can be reliably repaired with acceptable complication rates. Our approach has been to perform a direct supported repair through an open approach, using uncoated midweight polypropylene mesh placed intraabdominally or deep to the external oblique muscle. In this article, we analyze a consecutive series of 31 patients who underwent repair of a flank defects performed by the senior

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author (G.A.D) over the past 13 years, focusing on technique, intraoperative findings, and outcomes.

PATIENTS AND METHODS

After approval from the Northwestern University Institutional Review Board, a retrospective chart review was performed for all patients who underwent flank defect repair performed by the senior author (G.A.D.) between 2001 and 2014. Flank defects were defined as complete or incomplete hernias or bulges of the abdominal wall lateral to the semilunar line after a prior flank incision. Any patients with a hernia that extended medial to the semilunar line as part of a thoracoabdominal incision were excluded, as were Kocher incisions and chevron-shaped liver transplant incisions. A hernia was defined as a full-thickness defect of at least one of the three lateral abdominal wall muscles, whereas a bulge was defined as all three muscle layers being in continuity but with eventration. Recurrence was determined by either physical examination at last follow-up or by radiographic evidence on most recent imaging. Length of follow-up was also calculated from the last physical examination or abdominal computed tomographic or magnetic resonance imaging scan. Surgical-site infections and occurrences were defined according to the American College of Surgeons National Surgical Quality Improvement Program occurrence variables and definitions.[10] Recurrence was defined as any significant recurrent bulge or hernia at the operative site.

Operative Technique

The following procedure is used for the repair of flank defects electively and without gross contamination. The patient is placed in the lateral decubitus position, carefully padded, with the planned incision at the break of the surgical table. Under general anesthesia, the original scar is incised and markedly extended to facilitate later skin tailoring (Fig. 1). The abdominal wall and/or hernia sac is incised through the prior scar to enter the abdomen, and the inner aspect of the abdominal wall is cleared of omentum and bowel. At this point, skin flaps are raised widely cranially and caudally, 4 cm past the level at which the abdominal musculature feels intact by a pinch test. In the overwhelming majority of cases, the internal oblique and transversus abdominis muscles can be palpated as a thickening of the abdominal wall layers. Digital traction is placed on this thick aspect of the abdominal wall to assess how easily these two shelves of muscle tissue can be

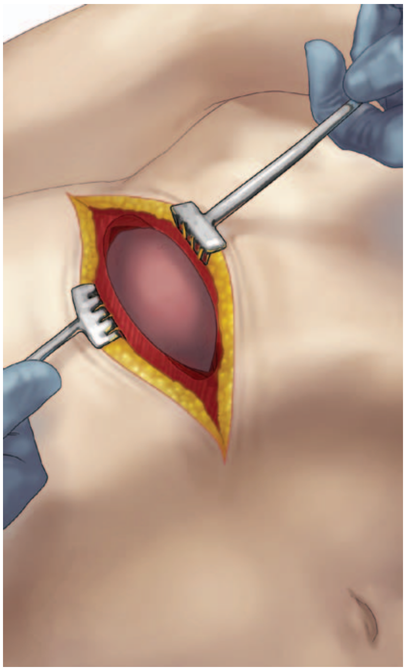

Fig. 1. The prior incision is extended and the hernia sac is exposed, often by incising the external oblique.

approximated when the operating table is placed in the reflex position. If these can be closed and the defect is relatively posterior, two deep muscle layers are closed with a 2-0 polydioxanone or equivalent suture, and mesh is placed in an underlay deep to the external oblique (Fig. 2). If tissue quality is poor and the two deep muscle layers can only be closed with positioning and tension, mesh is placed intraperitoneally as an underlay (Fig. 2). The closer the defect is to the semilunar line, the more likely intraperitoneal placement is required. Regardless of the plane of mesh placement, the technique of mesh placement is the same. A 7.5-cm-wide piece of soft midweight polypropylene mesh (Soft Prolene; Ethicon, Inc., Somerville, N.J.) is cut with a length several centimeters longer than the transverse length of the defect (Fig. 3). The mesh is oriented so that tension across the mesh to close the defect will maintain the mesh pores open and macroporous. For the mesh used in this study, the blue lines are oriented parallel to the long axis of the hernia. By palpation, this particular mesh has both smoother and rougher surfaces, and the smoother side was placed facing the bowel when used intraperitoneally. Mesh is sutured into place with interrupted 0 polypropylene sutures in a horizontal mattress fashion with transmuscular bites approximately 4 cm from the edges of the defect and 0.5 cm from the edge of the mesh (Fig. 4). Bites are taken close to the

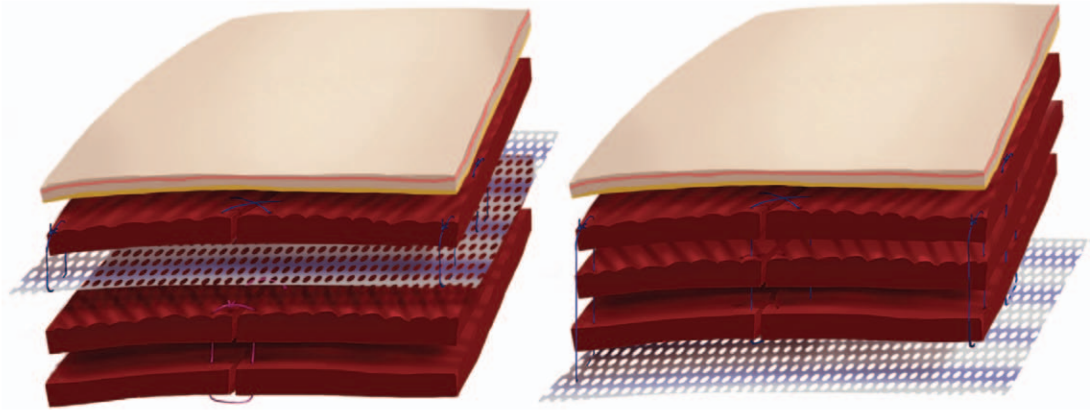

Fig. 2. Choice of mesh plane of placement. If the transversus and internal oblique can be reliably closed primarily without tension, mesh is placed deep to the external oblique (*left*). If these layers cannot be closed reliably, mesh is placed intraperitoneally (*right*).

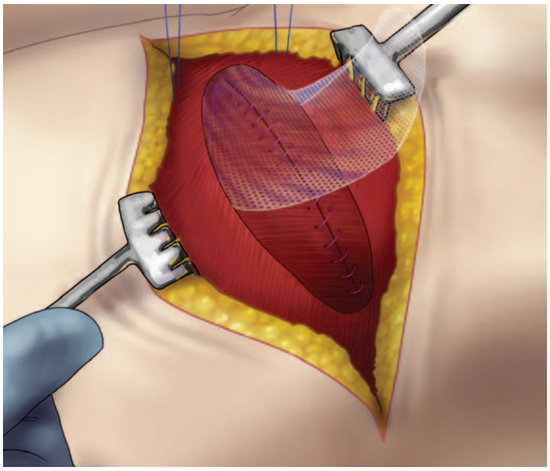

Fig. 3. A 7.5-cm-wide strip of uncoated midweight polypropylene mesh is used. Mesh placement deep to the external oblique after primary closure of the internal oblique and transversus abdominis is shown.

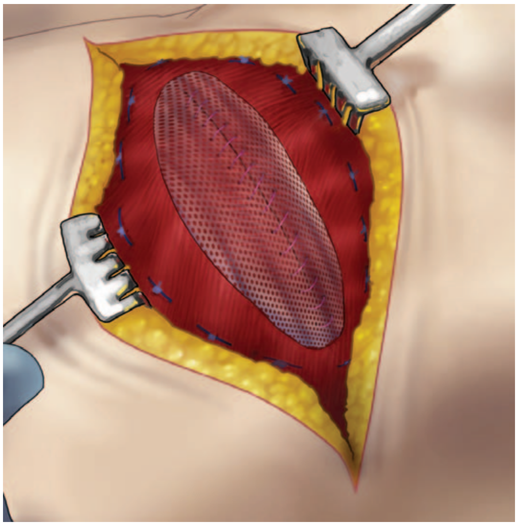

Fig. 4. Mesh is sutured into place with interrupted 0 polypropylene sutures in a horizontal mattress fashion with transmuscular bites approximately 4 cm from the edges of the defect and 0.5 cm from the edge of the mesh.

edges of the mesh to minimize wrinkling of the mesh from the suture. Bone anchors, transosseous suturing to the iliac crest, or sutures around ribs are avoided, as is discussed later. As the mesh is slightly narrower (7.5 cm) than the distance between sutures on each side of the abdominal wall (4 cm × 2 = 8 cm), the lateral abdominal musculature falls together without tension along the axis of the mesh. In the case of sub–external oblique mesh, the internal oblique and transversus abdominis are closed initially with the aid of the table placed in the reflex position. Redundant external oblique muscle is excised, and good quality muscle is then closed with figure-of-eight 0 polypropylene sutures (Fig. 5). With this type of closure, the mesh and abdominal wall suture lines serve as a load-sharing construct to evenly distribute the forces of closure and to lower the forces at each suture/tissue interface to minimize suture pull-through, which is a primary cause of hernia recurrence. After muscular closure, redundant skin (which is uniformly present) is excised to reduce dead space, and one or two drains are placed superficial to the external oblique. Abdominal binders are used to compress the surgical site to aid in wound healing. Antibiotics are given preoperatively and for 24 hours after surgery. Drains are removed when the patient has returned to normal activity and output is less than 30 ml/day. Patients are typically kept in the hospital until return of bowel function. Ambulation begins on the first postoperative day.

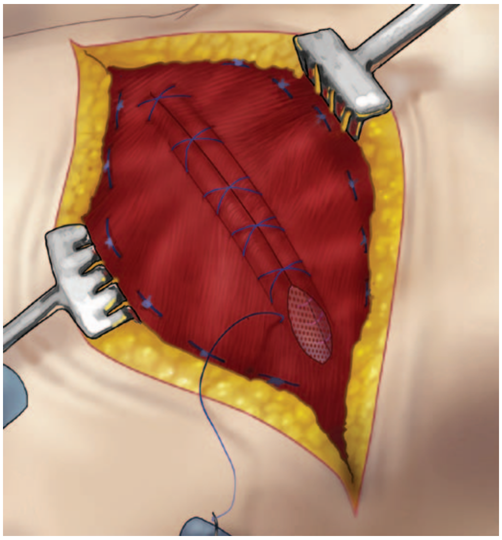

Fig. 5. After excision of redundant muscle, the external oblique is closed with figure-of-eight suture in line with the mesh, creating three load-sharing suture lines.

It is important to note that this technique is used for both hernias and bulges of the lateral abdominal wall. In the case of denervation injuries with all muscle layers intact, the external oblique is incised and the lack of hernia is confirmed. Laxity is removed from the internal oblique and transversus abdominis either with plication or with direct excision. Judgment is required to distinguish by palpation normal thickness muscle from denervated and thin muscle. Mesh is then placed under the external oblique with the same technique as outlined above.

RESULTS

A total of 31 patients met inclusion criteria. Mean age was 57.6 ± 11 years, and mean body mass index was 31.9 ± 7.3 kg/m^2. Twelve patients (39 percent) were current smokers, and three transplant patients used chronic corticosteroids and immunosuppressants. The average number of prior abdominal operations was 1.9 ± 1.2. Average transverse defect size 11.1 ± 5.6 cm by computed tomographic scan; however, the more important vertical separation between the two internal layers of the abdominal musculature was difficult to quantitate. Hernias had been present for a mean of 1.5 ± 1.6 years. There were three patients who qualified as Ventral Hernia Working Group grade I (low risk), 27 were classified as grade II (comorbid), and one patient was classified as grade III (potentially contaminated). The procedure leading to the flank hernia was urologic (including kidney transplants) in 22 patients, vascular in four patients, spine access in two, and other in three. On operative exploration, 10 patients had a complete hernia through all layers of the lateral abdominal musculature, 17 patients had eventration of the external oblique with dehiscence of the internal oblique and transversus abdominis (Fig. 6), and four patients had a denervation injury with all muscle layers intact. In all cases, uncoated midweight polypropylene mesh was used for repair. Mesh was placed intraperitoneally in 19 patients and extraperitoneally (between the internal and external oblique or in the preperitoneal space) in 12 patients. Three patients underwent significant lysis of adhesions and five patients had other surgical procedures performed concurrent with the hernia repair. In seven patients, a contralateral components separation was performed (after a formal position change) with a perforator-sparing technique as our group has described, to increase intraabdominal volume and improve compliance

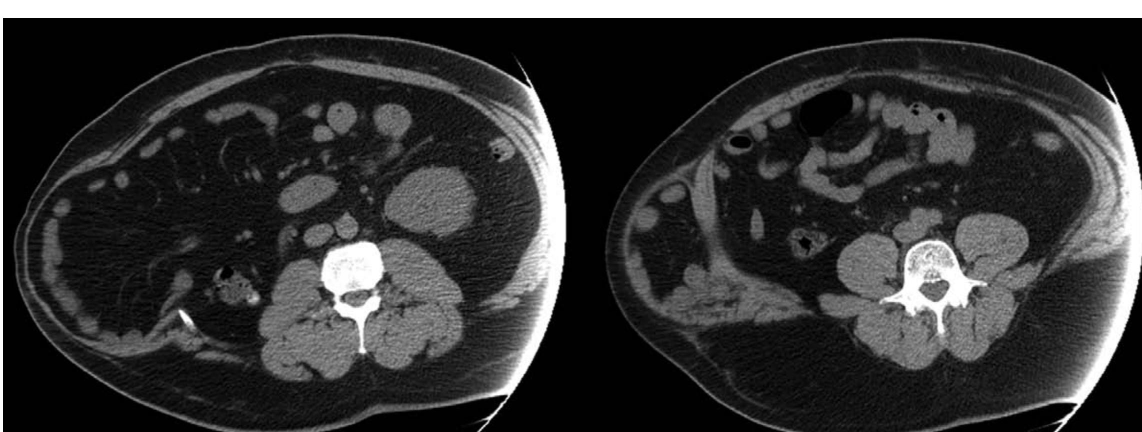

Fig. 6. (*Left*) On most cuts of this computed tomographic scan, the patient appears to have a true hernia or bulge alone (the patient also has a midline hernia). (*Right*) Careful examination reveals the external oblique to be intact and stretched, with the internal oblique and transversus muscles retracted.

for patients who clinically had a loss of domain and measured altered respiratory function preoperatively.[11,12] Fewer releases were performed in the later years of this series. Mean operating room time was 127.2 ± 36.0 minutes. Average duration of hospital stay was 4.3 ± 1.8 days; 1 day on average less than for midline hernia repairs performed with a similar technique by the senior author. Mean follow-up time was 830 ± 1051 days (range, 14 to 4532 days).

There were no surgical-site infections or 30-day surgical-site occurrences. There was one case of superficial wound breakdown managed with dressing changes. There were three recurrences. Two of these patients developed a minor bulge at the prior hernia site, one of which was repaired operatively with additional mesh placed in between the internal and external oblique muscles, and the other managed with observation. One small asymptomatic recurrent hernia was noted incidentally on follow-up computed tomography. Mean time until recurrence was 2.9 years (range, 1 to 5.8 years). All patients who developed a recurrence initially had an intraperitoneal repair. Although not a focus of this article, patients generally return to baseline function in 4 to 6 weeks. One patient had chronic pain at the hernia site preoperatively, which was not improved with repair.

DISCUSSION

Flank hernias and bulges after surgical approaches through the lateral abdominal wall are quite common, with an incidence as high as 50 to 57 percent after open nephrectomy.[8,9] This complication has proved to be a challenging and controversial topic in abdominal wall reconstruction. Indeed, even the cause of these bulges has been debated, with opinions differing from true hernias to bulges related to denervation.[6,10,13,14] As such, the recommended management of this problem has also been varied. Laparoscopic and open approaches have been described, as have flap-based repairs.[2,3,15–17] Reinforcement has been performed with suture alone, mesh placement through nearly the entire preperitoneal space with bone anchors to the iliac crest,[3,4] and wide skin undermining and placement of overlay meshes. Laparoscopic techniques have also been described; however, these are less applicable to our patient population, as they do not address bulges and may be more appropriate for smaller defects.[14,18,19] Regardless of the technique, flank defects are regarded as challenging surgical problems.

Unfortunately, results reported as flank hernia repairs have been as varied as the techniques themselves. Petersen et al. described an underlay mesh placement that resolved the hernias but did not repair bulges in four patients.[2] Hoffman et al. described an abdominoplasty approach with muscle plication and overlay mesh in three patients, with one recurrence.[15] Zieren et al. described seven patients repaired through the flank incision with two recurrences and a 100 percent bulge rate afterward, and eight hernias repaired through a midline incision with a large preperitoneal underlay mesh with no recurrences.[16]

The paucity of data regarding repair of flank bulge is surprising, given the incidence of this problem. Three larger studies exist regarding their repair. Veyrie et al. reported a series of 61 lateral incisional hernias (14 subcostal, 12 flank, and 35 iliac fossa) repaired with a large underlay polyester mesh between the internal and external oblique muscles. They reported three recurrences (one subcostal and two iliac fossa) and an 18 percent complication rate.[20] Phillips et al. described essentially a total retromuscular polypropylene mesh reconstruction from iliac crest to above the costal margin in 16 patients. They reported no recurrences and a 33 percent complication rate.[3] Finally, Moreno-Egea et al. described an open repair in 20 patients with mesh placed in both the preperitoneal space and as an overlay on the external oblique muscle. They reported a 15 percent recurrence rate and a 40 percent complication rate.[18] Our study compares favorably with these, with 31 patients (6 percent of patients with a recurrent bulge, one patient with recurrent hernia, and one patient with a minor wound complication).

Our technique differs from those previously in the literature because we describe a repair that addresses bulge *and* hernia; thus, we consider eventration or bulging as a recurrence as well (Fig. 7). Our repair is standardized regardless of hernia location and stems from several key principles.[21] The first of these is that hernia repairs fail because of suture pulling through tissue. Therefore, the surgical goal is to create a repair or construct that lowers the force at each suture/tissue interface, through distribution over more of these interfaces.[22] This is accomplished through use of multiple transabdominal 0 polypropylene sutures and the use of mesh in a load-sharing manner. Three lines of sutures (two transabdominal on the mesh and one reapproximating the abdominal wall) in this technique results in more even distribution of forces through the 25 to 35 fascial sutures. The

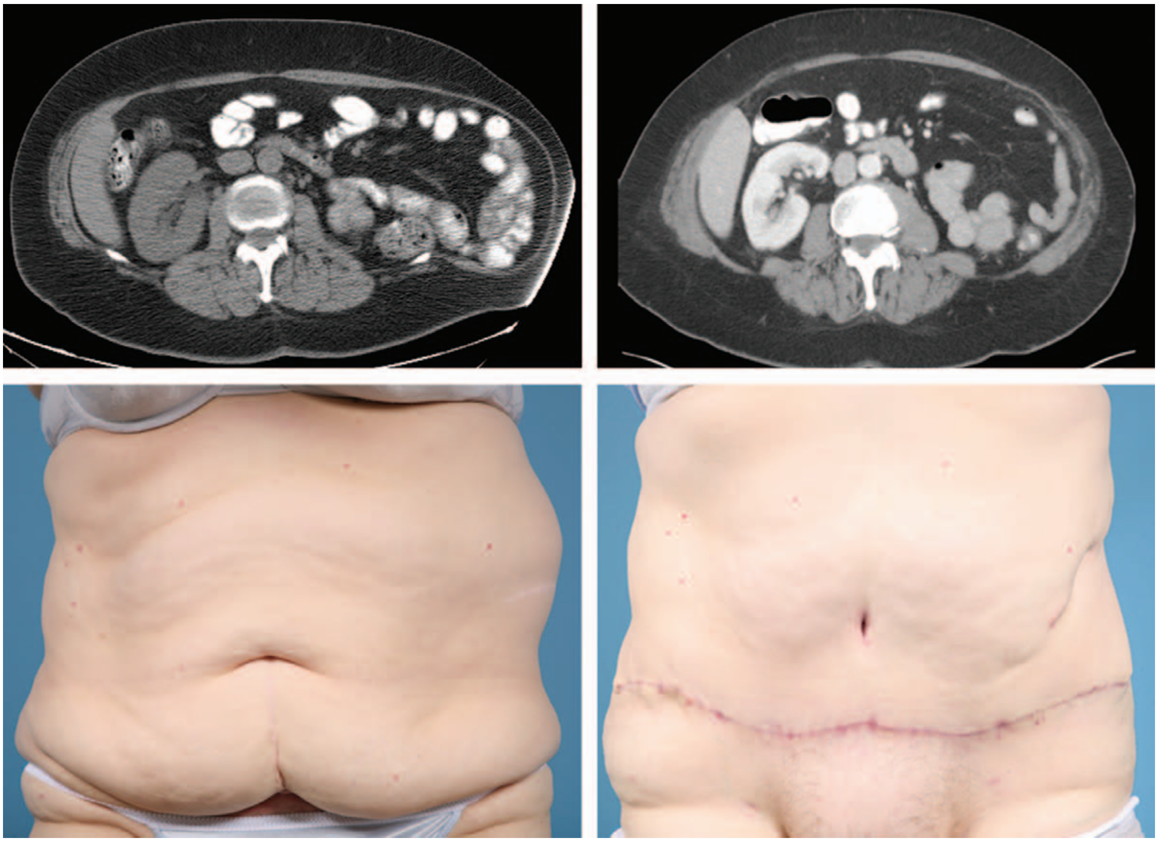

Fig. 7. (*Left*) A 62-year-old woman with a true left flank hernia after a nephrectomy, which was repaired with intraperitoneal mesh and a concomitant abdominoplasty. (*Above*, *right*) Computed tomographic scan at 2-year follow-up reveals maintenance of repair. (*Below*, *right*) Six-month photographic follow-up shows improved lateral abdominal contour.

amount of mesh used (7.5 cm wide in a strip) is much smaller than in many described repairs. This decreases the amount of soft-tissue elevation required for placement, perhaps contributing to our low surgical-site infection and surgical-site occurrence rates. Moreover, this smaller mesh avoids mesh wrinkling, decreases the amount of prosthetic that could potentially become infected, and minimizes mesh surface area onto which bowel could potentially form adhesions. The outcomes of intraabdominal mesh placed in this manner for midline closures has been documented to have similar recurrence and complication rates.[23–25] Biological mesh is not used in any case, given concerns regarding a high rate of recurrence.[24,26–29] Although it is preferential that mesh be placed in a retromuscular underlay between the external and internal oblique, we do not hesitate to place mesh intraperitoneally if a retromuscular placement sacrifices repair quality.[23,27]

It is also our opinion that osseous stabilization of mesh is not only challenging but also potentially counterproductive. We suspect that the forces at the suture/tissue interface are greatest in a stiff abdominal wall, and lowest when placed in compliant musculature. For this reason, patients who have lost weight or have had prior ascites have successful hernia repairs, as their musculature does not gain tension when extended. Bone anchors and transosseous suturing serve to create a completely fixed site and a compliance mismatch that will not be in balance with the other mobile areas of mesh fixation. We avoid fixed points as much as possible, rather always preferring to suture mesh to mobile structures, remembering the old adage and applying it to surgery that “the reed bends, while the oak tree breaks.” We also believe that larger meshes may increase pain or sensation of “feeling the mesh” from an expansive area of abdominal wall with altered compliance. The instances where osseous fixation is required tend to be after abdominal wall tumor excision where no abdomdinal wall remains attached to the iliac crest or ribs. In these cases, osseous fixation is achieved with a cannulated Kirschner wire to pass the suture through bone.[30]

Only a single mesh was used for this series. Mesh macroporosity with openings greater than 1000 μm are important ensure a biocompatible tissue incorporation response.[31] The mesh pores should be stretched open with loading; thus, the blue lines of this particular mesh should be oriented transversely. Although the authors suspect that a permanent mesh is necessary to maintain a lifelong foreign body reaction and scar, this is only tangentially supported in the literature.[32]

Our case series also supports our hypothesis that a majority of flank defects are actually hernias through the internal oblique and transversus abdominis, with eventration of the external oblique. In fact, only four patients in this study had generalized laxity of the abdominal wall without either an internal/transversus dehiscence or complete hernia on operative exploration. This is the first description of this phenomenon, although this concept is hinted at in a previous publication, describing incising the external oblique to expose the flank hernia sac.[17] In light of these findings, we feel that flank "denervation injury" alone is often an error in diagnosis and that a true hernia is present in a large proportion of these patients. A computed tomographic scan can often be misleading in diagnosis of internal oblique/transversus dehiscence unless this is specifically being searched for, as the posterior sheath muscles will often retract significantly cephalad and caudal to the incision. It is our opinion that denervation bulges do occur, especially in cases associated with spinal surgery, but the prevalence of this cause of flank bulges from denervation has been greatly overestimated.[33] There is significant branching of nerves in the transversus abdominis plane, and although flank incisions will invariably sever some of these, injury to a main nerve trunk would be required to result in a large area of complete denervation.[34] Flank incisions are typically placed in dermatomes parallel to nerves, and therefore only a minority should be affected. Certainly, strategies to avoid nerve injury in flank incisions should be used, given that the cause of flank hernias is likely multifactorial and nerve injury could play a role in the hernias themselves.[1,35]

Even in the face of denervation, our technique was successful in achieving repair of a bulge solely caused by laxity in all four patients who initially presented with this issue. Given these results, the nihilism associated with flank bulging does not seem warranted. Interestingly, two patients (both of whom were true hernia patients with intraperitoneal mesh placement) did develop clinically significant bulging of the abdominal wall after their repair. This tends to occur at the semilunar line, where a dog-ear of the closure develops, and is difficult to tighten because of the vertically oriented rectus muscle that resists transverse plication. One patient desired operative repair for cosmetic reasons, and this was corrected with a technique similar to our original repair, but with additional mesh placed in the plane between the external and internal oblique muscles as an underlay that was carried out onto the anterior rectus fascia.

This study is limited by its nature as a retrospective chart review. However, as follow-up was defined as either the last physical examination by the senior surgeon or by routine computed tomographic scan, our follow-up of greater than 2 years seems adequate and representative overall of our positive outcomes with this clinical problem.

CONCLUSIONS

We present a large series of flank defects with a structural approach to their repair. Our repair focuses on force distribution, can successfully treat both hernias and bulges, and has low complication and recurrence rates. The majority of flank defects represent either true hernias or dehiscence of the inner two layers of the abdominal wall with an intact external oblique muscle.

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