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SPECIAL TOPIC
Reconstructive

Lateral Abdominal Wall Defects: The Importance of Anatomy and Technique for a Successful Repair

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Summary: Flank and lateral abdominal wall defects can be an extremely challenging phenomenon for surgeons to undertake. Their rarity and specific idiosyncrasies in regard to embryologic and anatomical characteristics must be taken into consideration when formulating an operative plan. We will discuss these cardinal points including technical recommendations by notable experts in the field to gain a better understanding in the diagnosis and treatment of this infrequent but morbid occurrence. *(Plast Reconstr Surg Glob Open 2015;3:e481; doi: 10.1097/GOX.0000000000000439; Published online 18 August 2015.)*

Flank and lateral abdominal wall defects are a rare and challenging entity for surgeons as they differ vastly in regard to their embryology, anatomy, etiology, and pathophysiology. They remain an infrequent topic of discussion in the literature despite the potential for fatal consequences. Various approaches have been reviewed in detail and have produced promising results. But, despite this, there is no general consensus regarding the proper method of repair nor have there been any prospective analyses.[1]

Lateral wall defects typically result from iatrogenic causes, trauma, and are rarely congenitally acquired. Traumatic abdominal wall hernias were first recognized in 1906 after a fall.[2] Since then, the blossoming of the automobile industry has afforded a proportional rise in the incidence of flank hernias. Some theorize that this, in part, resulted from less efficient and unsafe seat belts in conjunction with more comprehensive diagnostic modalities in the acutely injured patient.[3] True congenital lateral wall defects are exceedingly rare, with very few reported cases. They are less common than gastroschisis, omphaloceles, and midline defects and comprise less than 1% of all congenital abdominal wall defects.[3–5]

In this article, we aim to review the embryologic and anatomical considerations as well as the intraoperative techniques discussed by notable experts in the field to gain a better understanding in the diagnosis and treatment of this rare occurrence.

EMBRYOLOGY

Embryologically, the primitive abdominal wall is the result of the complex interplay of multiple primary germ cell layers. The abdominal wall arises from the somatopleure and includes a layer of ectoderm and endoderm. During the fifth week of development, mesoderm located near either side of the vertebral column invades the somatopleure. This mesoderm divides into the paraxially located epimere and the laterally positioned hypomere both separated by an intermuscular septum. The anterior edges of the "v" form both rectus muscles and split into 3 layers. These layers give rise, by the seventh week, to the external oblique muscle, the internal oblique muscle, and the transversus abdominis muscle. The cooperation of this lateral anatomy aids in understanding and treating lateral wall defects.[6]

ANATOMY

Anatomically, lateral wall defects are unique. They can be categorized as flank hernias or bulges

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Received for publication April 28, 2015; accepted June 3, 2015.

DOI: 10.1097/GOX.0000000000000439

Disclosure: *The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.*

and can be the result of myofascial laxity. The lateral abdominal wall territory has been described horizontally as the region from the linea semilunaris to the posterior paraspinal muscles. The vertical extent of this area is from the costal margin to the iliac crest. This differs from the central abdominal wall, which is bordered laterally by linea semilunaris, cranially by the medial costal cartilage, and caudally limited by the pubic bone and medial aspect of the inguinal ligament.[7] The lateral abdominal wall musculofascial interface begins at the lateral border of the rectus muscle where the aponeurosis alternatively separates or fuses to engage with the rectus sheath. At this point, the external oblique aponeurosis and rectus sheath mesh to form the linea semilunaris. The internal oblique aponeurosis splits to contribute to the anterior and posterior rectus sheath above the arcuate line, whereas below this landmark, no such split exists and the aponeurosis fuses with the external oblique fascia to form only the anterior rectus sheath. The posterior sheath above the arcuate line consists of the transverse abdominis muscle's aponeurosis and the posterior lamina of the internal oblique. Below the arcuate line, the rectus abdominis is anterior to only the transversalis fascia.[8] Thus, the relationships between the external and internal oblique muscles, transversus abdominis muscle, transversalis fascia, and obliquely situated neurovascular bundles are integral in lateral pathology. These layers are tenuous and have scarce aponeurotic tissue accounting for the difficulty in repairing defects in the region. Furthermore, although less frequent than central wall defects, lateral wall defects have a greater surface area for potential hernia or bulge development and can rapidly expand asymmetrically. It is this disproportionate strain on the abdominal wall that leads to aberrant musculofascial dynamics and causes herniation, bulge, lumbar spine ligamentous strain injury, and lower back pain (Figs. 1, 2).[7]

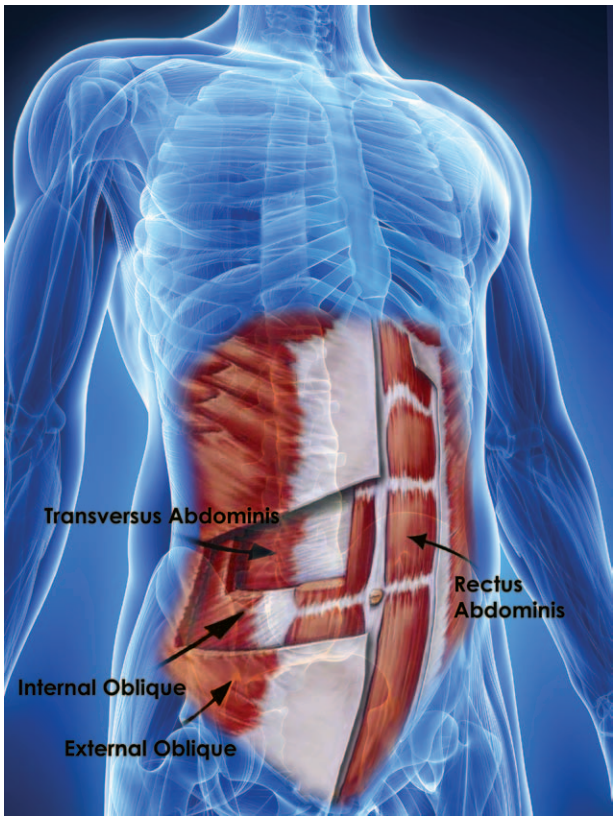

Fig. 1. The anatomy of the abdominal wall.

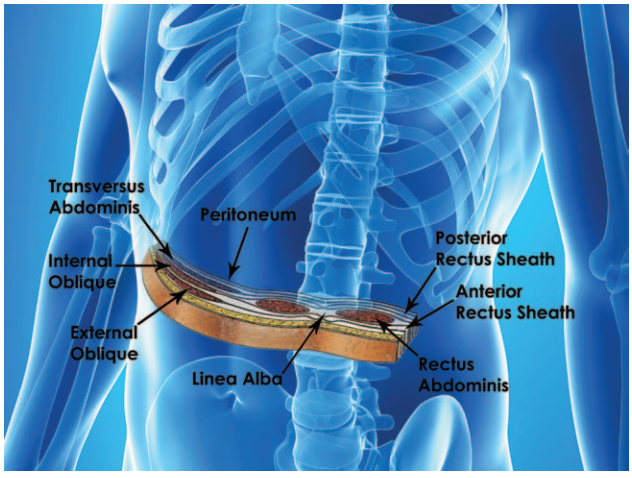

Fig. 2. The anatomy of the abdominal wall in detail.

ETIOLOGY

Within the general category of lateral wall defects, there are multiple subdivisions. These were best described by Baumann and Butler[7] and include paramedian, lateral, subcostal, and paraspinal defects. Paramedian defects, such as Spigelian hernias, involve the intact linea alba and abnormal linea semilunaris. Lateral defects involve the aforementioned oblique muscle conglomeration and their attachments cranially to the costal margin and caudally to the iliac crest. Subcostal defects include the upper abdomen, chest wall, and potentially the diaphragm. Lumbar defects are synonymous with paraspinal defects and involve the origins of the external oblique, internal oblique, and transversus abdominis. Grynfeltt hernias occur along the superior lumbar triangle, whereas Petit hernias reside along the inferior lumbar triangle. Grynfeltt hernias are bordered by the internal oblique, the paraspinal muscles, and the 12th rib. Petit hernias are limited by the external oblique, the latissimus dorsi, and the iliac crest. Each of these subdivisions is accompanied by a different etiology and a potentially nuanced treatment.[7]

Iatrogenic causes are recognized as the major etiologic culprit for lateral wall defects. The abdominal musculature innervated in segments by the T7–T12 spinal roots.[9] Disturbance of these nerves can lead to weakening of the lateral wall musculature, generating bulges or hernias. Certain procedures leave patients more vulnerable to suffer from this phenomenon. Flank bulges were noted in 50% of patients undergoing radical nephrectomy with a flank incision.[10] The etiology of an abdominal bulge following breast reconstruction with the deep inferior epigastric perforator flap is uncertain. Most studies report an incidence that ranges from 0.7% to 5%.[11] Surgeries obliging the use of a retroperitoneal incision have a greater potential to cause bulging.[12] Incisions in the weaker regions of the abdominal wall such as the Kocher and Chevron incisions used in hepatobiliary surgery and oncologic resections can result in lateral wall defects.[7] Rarely, incisional intercostal hernias with prolapsed colon have even been reported after right partial nephrectomy with a flank incision.[13] In central wall defects, recurrence rates after a primary repair can vary drastically from 24% to 54%. Even with the employment of mesh, recurrence rates are still about 24%.[14–18] Given the anatomic and physiological idiosyncrasies, it is plausible to suppose that lateral defects are more likely to recur.

OVERVIEW OF TECHNIQUES

Baumann and Butler[7] describe general reconstructive principles in their recent review. They demonstrate the inherent flaws of a single-layer interposition mesh bridging mesh repair. Because of the paucity of nearby soft tissue, a second layer of coverage (normally abundant in central defects) is typically impossible. As this mesh is approximated to deinnervated muscle, asymmetric laxity develops resulting in a bulge. Similar outcomes result with onlay repair methods due to the fact that peripheral muscle weakness is not addressed. It is proposed that the solution is to void "patchwork" and place an intra-abdominal inlay mesh fixed to points beyond the attenuated oblique muscle network. The mesh can be either bioprosthetic or synthetic based on surgeon preference. We recommend acellular dermal matrix as this allows for conservative management in the event of postoperative wound complications. Emphasis is placed on fixation to innervated musculofascia, lamellar aponeurotic tissue, or bone. These abdominal wall stability pillars are likened to the strength and stability pillars associated with craniofacial surgery. The solid fixation points include costal margin and rib superiorly, the linea semilunaris anteromedially, the inguinal ligament and iliac crest inferiorly, and the investing lumbar and paraspinal fascia posteriorly. With attachment to these points, Baumann and Butler[7] report that their method addresses both bulges and hernias. In addition to these maneuvers, in rare instances, they have noted success using pedicled and free flaps such as the vertical rectus abdominis flap, latissimus flap, omental flap, anterolateral thigh flap, vastus lateralis flap, and tensor fascia lata flap.[7]

Hope and Hooks[19] in 2013 reviewed atypical hernias and described their approach to flank defects. With these hernias, the sac is left intact and dissected laterally to the fascial edges. If the sac cannot be located, all layers of the abdominal wall are divided. Mesh placement, in their hands, is best placed in the preperitoneal plane and fixed posteriorly first to the iliac crest. Next, medial fixation to linea alba is performed. Then inferior and superior anchoring is attempted to the costal margin and Cooper's ligament, respectively. The most emphasis is placed on a wide overlap of the mesh to produce physiologic tension. This amount of overlap is dependent on tension needed and is a subjective measure. In addition to open repair, they describe a laparoscopic approach in which the patient is placed in the lateral decubitus position and 3–5 trochars are used. The operative sequence includes adhesiolysis, colonic take-down, peritoneal mobilization, hernia measurement, mesh preparation, mesh fixation, and closure.[19]

Along similar lines, Phillips et al[20] use a retromuscular or sublay preperitoneal technique for flank hernia repair. The preperitoneal space is entered posteriorly and the peritoneal sac is swept medially. The ureter, gonadal vessels, and major vessels are identified to avoid inadvertent injury during mesh fixation. The plane is dissected to Cooper's ligament and extended 5–10 cm under the costal margin. The medial dissection progresses toward the posterior rectus sheath. A synthetic mesh is then secured with transfascial sutures, spaced 5–10 cm apart, in the retrorectus position preperitoneally. It is secured under the rib cage to the midline and iliac crest. By using the preperitoneal space effectively, large subcutaneous skin flaps are not created, affirming their repair adheres to the tenet of wide mesh overlap.[19]

Bender et al[3] described the acute and chronic management of traumatic flank hernias. Usually occurring after blunt injury, they advocate a tension-free primary closure using interposition or reinforcement (intermuscular) mesh placement using a flank approach. Bone anchors drilled through the iliac crest are described when inferior and posterior fasciae are lacking. The repair is taken as far back as the quadratus lumborum. In the trauma setting, they recommend that full-thickness injuries be safely delayed to address other comorbidities and traumatic injuries.[3]

Peterson and coworkers[21] prospectively reviewed their experience with the sublay technique for incisional flank hernia, largely after a nephrectomy procedure. They first describe and differentiate incisional hernias from other types. Incisional hernias develop in the ventral region of the flank incision directly into the lateral fascia of the straight abdominal muscle. This differs from lumbar hernias that occur in the triangle between the iliac crest, straight spinal muscle, and oblique external muscle. Incisional flank hernias differ from paralytic muscular bulge and they propose computed tomography for imaging. Only true hernias with a palpable edge are repaired with mesh. The authors place mesh preperitoneally with variation in the choice of prosthetic material based on intestinal contact. If mesh will be in contact with intestine, expanded polytetrafluoroethylene is used. If peritoneal closure is possible beneath the mesh, polypropylene or polyester mesh is used. They opt for the sublay positioning of the mesh and recommend wide overlap by using large meshes averaging 25 cm × 38 cm.[21] This sublay positioning (especially the extended sublay position) was noted to have a statistically significant decrease in late complications such as recurrences or bulges as noted by Fei and Li.[22] Furthermore, laparoscopic repair is not ideal due to the difficulty in maneuvering and securing large portions of mesh. Finally, despite optimal technique, patients are routinely made aware of the potential for persistent pain, discomfort, and bulge.[21]

Zieren et al[23] used a novel technique for the repair of flank hernias and bulging after open nephrectomy. They used a median laparotomy, instead of a flank incision, and performed transabdominal hernia sac reduction. Next, a prosthetic polypropylene mesh was overlapped with the midline using a sublay technique. They propose that the median laparotomy enables free access to healthy and unattenuated tissue allowing for accurate hernia sac reduction. The mesh is fixed medially to the contralateral rectus sheath and laterally to the posterior rectus sheath. In doing so, paralyzed muscle is avoided as well as the notoriously painful cranial fixation to the thoracic wall. Most importantly, fixation to the contralateral wall equilibrates tension restoring musculofascial dynamics and enables abdominal wall "remodeling."[23]

Flank bulge repair is a particularly onerous task. Hoffman et al[24] reported an incidence of flank bulge after peritoneal violation during vascular surgery to range from 11% to 23%. The surgical repair entailed an abdominoplasty incision extending from the suprapubic area to the iliac crests and continued to a plane superficial to the anterior rectus sheath. This was advanced cranially to the xyphoid process and bilateral costal margins. The rectus abdominis muscle is plicated transversely and reinforced with a polypropylene mesh. The abdominal skin is resected as a standard abdominoplasty.[24] Pineda et al[25] similarly addressed the flank bulges but used a myofascial flap to relieve pain and improve cosmesis. These authors divided the external oblique, identified and reduced the hernia sac, and released internal oblique myofascial flaps. The inferior and superior flaps are secure to each other, and a mesh is placed over the flap construct.[25]

Pezeshk et al[26] described a series of lateral abdominal wall reconstruction procedures performed by senior surgeon (R.E.H.). Their technique was grounded on the use of a musculofascial flap advancement and primary nonbridged inlay repair to enable anatomic congruity using acellular dermal matrix to reinforce the surrounding musculofascial closure. When this is not feasible due to damage of the surrounding myofascial tissue, particularly in patients with previous surgical intervention or denervation, the next choice is an underlay repair. Both methods reinforce the primary repair, restore anatomic physiology, and protect the acellular dermal matrix from potential exposure. One patient out of 29 suffered a recurrence during a mean follow-up period of 21.2 months.

Lumbar hernias represent a subset of lateral wall defects with unique surgical treatments. Stamatiou et al[27] report the importance of repair of these hernias due to the 25% risk of incarceration and 8% risk of strangulation. The hernia can be repaired through a posterior approach or through an anterior retroperitoneal approach. For small hernias, primary closure with the lumbodorsal fascia and nearby musculature can be performed. For larger hernias, a mesh by itself or in combination with a tissue flap can be used. The described Dowd-Ponka repair involves an oblique incision over the lumbar hernia and subsequent patch anchored to muscles and periosteum. Gluteal fascia is cut and rotated to complete mesh coverage.[27] Cavallaro et al[28] used a lumbar hernia repair that addressed Grynfelt and Petit hernias using tension-free synthetic mesh placement in the extraperitoneal space beneath the muscular layers.

CONCLUSIONS

Flank hernias are truly unique in every sense. The same principles used to repair central wall defects will not yield consistently successful results. Lateral wall defects do not afford redundant fascia or the ability to mobilize the various muscular layers accounting for the high rates of recurrences reported in the literature.[7] A proper understanding of anatomy and techniques must be grasped before a surgeon can truly engage this challenging endeavor.

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