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IDEAS AND INNOVATIONS

Reconstructive

Technique of Abdominal Wall Tissue Expansion for the Treatment of Massive Complicated Ventral Hernias

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Summary: Abdominal wall tissue expansion is a unique technique that seeks to augment and expand both the fascial and subcutaneous tissues/skin layers to achieve durable closure of otherwise challenging ventral hernias. In addition to allowing primary fascial closure in a majority of cases, this technique enables reduced tension on the closure, potentially decreasing the recurrence rate. This article describes the senior author's surgical technique for abdominal wall tissue expansion in massive complicated ventral hernias. The plastic surgeon is at a unique advantage to assist with the repair of massive complicated ventral hernias given their comfort with complex tissue handling and expandable devices. This specialized technique thus provides an opportunity for plastic surgeons to serve as expert co-surgeons with general surgery colleagues to help achieve superior outcomes in patients with these challenging hernias. *(Plast Reconstr Surg Glob Open 2022;10:e4095; doi: 10.1097/GOX.0000000000004095; Published online 9 February 2022.)*

INTRODUCTION

Abdominal hernia repair with components separation as described by Ramirez et al[1] in 1990 is a commonly performed procedure, and most repairs are relatively straightforward. However, a subset of these hernias exist in patients with significant loss of domain (>15 cm), involving large deficits of fascia, subcutaneous tissues/skin, or both.[2] These patients tend to have a history of extensive abdominal surgery, recurrent ventral hernias, and multiple other medical comorbidities.[3] All of these factors combine to make reconstruction of this subset of hernias difficult to treat.[4–6] In this article, the senior author's approach to the use of tissue expansion to allow repair of these defects is described in detail.

SURGICAL TECHNIQUE

First Stage: Placement of Expanders

Preoperatively, computed tomography is used to measure the width of the rectus fascia and the location of the semilunar line (Fig 1).[7] The anticipated incision lines are marked in the preoperative area with the patient in supine position. The patient is asked to flex, gently lift their head, and elevate their legs, with assistance. This maneuver allows the clinical examiner to choose the appropriate access incision sites by accurately identifying and marking the fascial defect.

Access incisions are 5–7 cm and made 1–2 fingerbreadths superior to the anterior superior iliac spine, just lateral to the estimated location of the semilunar line. Occasionally, if the hernia sac prevents access to the inferior external oblique aponeurosis (EOA), an upper abdominal incision is used instead.

When in the inferior location, the incision can often be incorporated in the transverse abdominal direction if a panniculectomy is planned. The EOA is identified based on the superolateral directionality of the muscle fibers. A 2- to 3-cm incision is made in the EOA one fingerbreadth lateral to the semilunar line. If a parastomal hernia is present, this incision is performed in a slightly more lateral position. Blunt finger dissection is used to identify the plane between the external and internal oblique muscles and a 10-mm laparoscopic balloon port trocar is placed. An inguinal hernia balloon dissector and a 30-degree laparoscope are inserted, and the correct plane is confirmed by visualizing the directionality of muscle fibers superficial and deep to the balloon. If adipose tissue, transversalis, or

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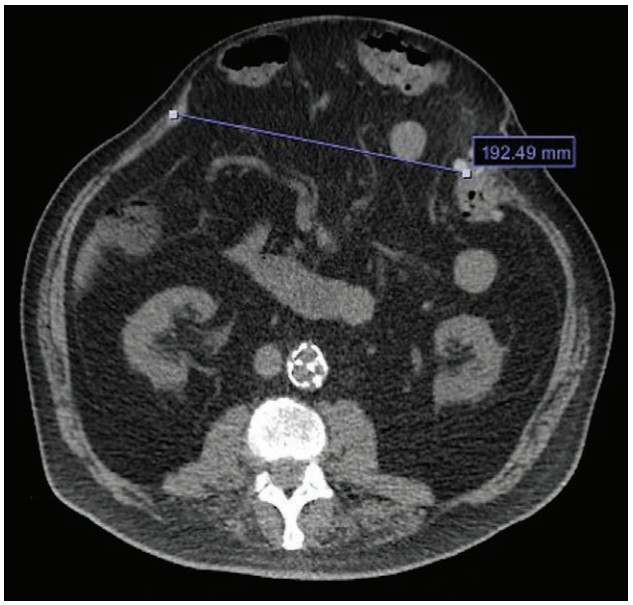

Fig. 1. Preoperative axial imaging and markings indicating size of fascial defect (19.2 cm in this case).

peritoneum is visualized, the trocar and balloon are repositioned to the correct plane. The balloon is inflated under direct vision. It is left inflated on the first side while the second side is being completed. Once the second balloon is inflated, the first side is deflated and hemostasis is confirmed. Typically, a large (600–800 ml) textured expander with an internal port is used. The incision in the EOA may need to be lengthened to allow for expander placement. The expander is soaked in half strength Povidine-iodine solution and inserted just deep to the EOA. We have found that folding the implant longitudinally helps. Correct positioning of the implant is confirmed and an initial fill of 300–400 ml ensures hemostasis and prevents expander migration. Finally, the EOA is closed with 2-0 PDS and Scarpa's fascia and skin is closed with 3-0 Monocryl. (**See Video 1 [online]**, which shows the technique of first stage of abdominal wall tissue expansion.)

Takeaways

Question: Is tissue expansion a viable option when component separation fails to achieve primary closure during herniorrhaphy of large complicated ventral hernias?

Findings: Using the surgical technique of tissue expansion outlined, patients in this pilot series achieved closure with acceptable recurrence rates.

Meaning: Tissue expansion of the abdominal wall can be an effective adjunct to component separation and ventral hernia repair in massive complicated ventral hernias.

Outpatient Expansion Process (2–12 Weeks)

The active expansion process typically begins in the second week. The expanders are filled every 1–2 weeks and incremental fill volume is determined by the patient's symptoms (tightness/discomfort). Expansion continues for 8–12 weeks until estimated tissue gain is greater than the width of the defect. For each expander, tissue gain = ([expander circumference/2] – expander diameter). Final fill volumes usually range from 1000 to 1500 ml.

Second Stage (8–12 Weeks after the First Stage)

The second stage is performed as a combined case with the general surgery service. A transverse access incision is typically used. This may be incorporated into a panniculectomy incision if a symptomatic pannus is present. Reduction and dissection of the hernia sac is performed. The fascial edges are identified and freshened for eventual primary fascial closure. Typically, removal of the expanders before hernia reduction and enterolysis is avoided, to minimize tissue retraction intraoperatively. (**See Video 2 [online]**, which shows the technique of second stage of abdominal wall tissue expansion.)

Removal of Expanders and Anterior Component Separation

The anterior rectus sheath is identified and is followed laterally to the capsule of the tissue expander bilaterally (Fig. 2A). The expanders are removed via a vertical incision 1 cm lateral to the semilunar line. If the tissue expanders are in the correct plane, they are removed via the same incision as the anterior component release. If

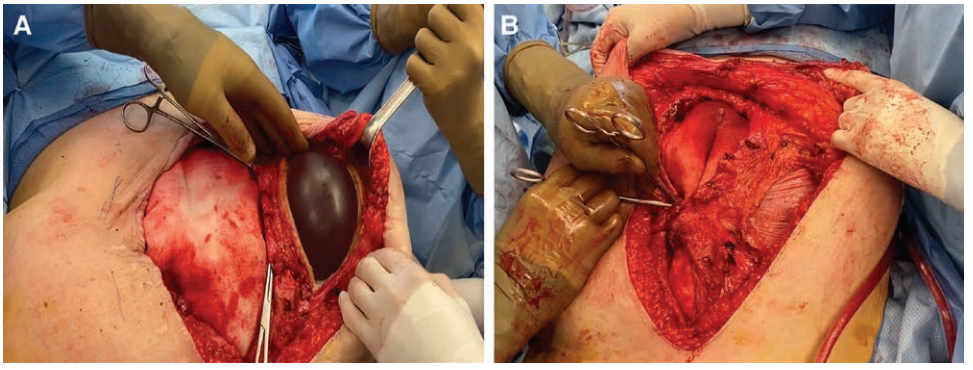

Fig. 2. Second stage of tissue expansion. A, Expander capsule opened for removal. B, Primary fascial closure of large defect enabled with minimal tension.

Table 1. Pilot Study Patient Characteristics

Total No. Patients	5
Average age (y)	62.6
Avg BMI (kg/m^2)	27.73
Avg diameter of defect (cm)	21 ± 5.0
Mesh bridge (n, %)	1 (25%)
Seroma (n, %)	1 (25%)
TE replacement (n, %)	0 (0%)
TE leak (n, %)	0 (0%)

the expanders were placed in the subcutaneous plane, they are removed and a standard anterior component separation is performed. The anterior component separation is completed by incising the EOA 1 cm lateral to the semilunar line from the pubis to above the costal margins bilaterally. The EOA inserts superior and superficial to the costal margin. The subexternal oblique plane is dissected posterolaterally up to the mid-axillary line.

The midline fascia is then assessed. Primary fascial closure is always attempted with #1 PDS suture using standard technique (Fig. 2B). If additional strength is required, a retrorectus mesh can be placed before fascial closure. Peak inspiratory pressures are closely monitored to ensure that abdominal closure does not adversely affect pulmonary physiology. If primary fascial closure is not possible, a temporary bridging mesh is used as an underlay. At our center, we prefer a combination of Bio-A or similar mesh for intraperitoneal protection and an outer polypropylene mesh for strength.

"Internal Corset" Mesh Placement

An additional reinforcement of a primary repair is always favored, and for this, an EOA underlay mesh repair can be used. A large polypropylene mesh underlay is placed deep to the edges of the bilateral EOAs, with at least 4–6 cm of overlap. This is secured under tension using a #1 PDS suture in running horizontal mattress fashion. Care is taken to ensure that the tension of this closure is higher than the midline closure, to offload midline tensile forces. The mesh is tacked superiorly and inferiorly with several interrupted #1 PDS sutures to prevent mesh movement. The free edges of the EOA are then advanced medially and secured to the underlying mesh using 2-0 PDS running sutures. If a panniculectomy is to be performed, any thinned or nonviable skin can be removed and the inferior skin edge can be advanced into the defect. Progressive tension sutures can be considered for closure to reduce the risk of seroma formation. At least two Blake drains are placed and the subcutaneous layer closed with 2-0 V-Loc to the superficial fascia and 3-0 V-Loc for the skin.

RESULTS

The characteristics of our pilot patient cohort are presented in Table 1. Overall, average body mass index (BMI) was 27.73. Average diameter of the defect was 21 cm. Most patients (81%) were classified under Ventral Hernia Working Groups II-III. The most common complication was seroma, which occurred in 25% of cases. The bridging mesh was used in 25% of cases.

DISCUSSION

Although the concept of using abdominal tissue expansion to facilitate the closure of difficult abdominal hernias is not new,[8–10] a reliable and systematic technique has not previously been described in the literature. In the present study, tissue expanders have been used for augmentation of abdominal wall fascia and subcutaneous tissue with success, despite extremely challenging abdominal anatomy and poor tissue quality. The recurrence rate in our cohort was approximately 15%, which is acceptable given the high average BMI and comorbidity of this cohort.

CONCLUSIONS

Achieving durable closure of massive complicated ventral hernias with acceptably low recurrence rates can be a challenge for the reconstructive surgeon. This article presents the senior author's surgical technique for abdominal wall tissue expansion, for both fascial and subcutaneous/skin deficits, a method that appears to facilitate improved closure rates in these difficult cases. Ongoing investigation through large-scale prospective studies will be needed to further elucidate the effectiveness of this strategy.

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REFERENCES

1. Ramirez OM, Ruas E, Dellon AL. "Components separation" method for closure of abdominal-wall defects: an anatomic and clinical study. *Plast Reconstr Surg.* 1990;86:519–526.
2. Ross SW, Wormer BA, Kim M, et al. Defining surgical outcomes and quality of life in massive ventral hernia repair: an international multicenter prospective study. *Am J Surg.* 2015;210:801–813.
3. Anthony T, Bergen PC, Kim LT, et al. Factors affecting recurrence following incisional herniorrhaphy. *World J Surg.* 2000;24:95–100; discussion 101.
4. Holihan JL, Alawadi Z, Martindale RG, et al. Adverse events after ventral hernia repair: the vicious cycle of complications. *J Am Coll Surg.* 2015;221:478–485.
5. Wormer BA, Walters AL, Bradley JF III, et al. Does ventral hernia defect length, width, or area predict postoperative quality of life? Answers from a prospective, international study. *J Surg Res.* 2013;184:169–177.
6. Jolissaint JS, Dieffenbach BV, Tsai TC, et al. Surgical site occurrences, not body mass index, increase the long-term risk of ventral hernia recurrence. *Surgery.* 2020;167:765–771.
7. Elfanagely O, Mellia JA, Othman S, et al. Computed tomography image analysis in abdominal wall reconstruction: a systematic review. *Plast Reconstr Surg Glob Open.* 2020;8:e3307.
8. Livingston DH, Sharma PK, Glantz AI. Tissue expanders for abdominal wall reconstruction following severe trauma: technical note and case reports. *J Trauma.* 1992;32:82–86.
9. Admire AA, Dolich MO, Sisley AC, et al. Massive ventral hernias: role of tissue expansion in abdominal wall restoration following abdominal compartment syndrome. *Am Surg.* 2002;68:491–496.
10. Alam NN, Narang SK, Pathak S, et al. Methods of abdominal wall expansion for repair of incisional herniae: a systematic review. *Hernia.* 2016;20:191–199.