Overview of Operative Approaches and Staging Systems for Ventral/ Incisional Hernia Repairs

Samir Ibrahim Mohammad Ibrahim, Amr Abdelbaset Abdelaziz, Abdelwhab Saleh Abdelwahab, Ahmed Attia Mohamed Attia Saleh

General Surgery Department, Faculty of Medicine, Zagazig University

***Corresponding author:** Ahmed Attia Mohamed Attia Saleh

Email: Mobile: +201060384352

Abstract:

While research on inguinal hernias is well-documented, ventral/incisional hernias still require investigation.

Keywords: Operative Approaches, Staging Systems, Ventral, Incisional Hernia, Repairs.

Tob Regul Sci.™ 2023;9(1): 6836 - 6849

DOI: doi.org/10.18001/TRS.9.1.478

Introduction:

With the multitude of operative approaches and variability amongst patients and hernias, defining a single, ideal operative approach is challenging and possibly unrealistic for ventral hernia repair. Additionally, surgeon preference and technical ability probably play the largest roles in determining an appropriate operative approach for patients undergoing ventral hernia repair. Some surgeons have been trained in minimally invasive surgery and prefer laparoscopic ventral hernia repairs over open ventral hernia repair, while others are more comfortable with open approaches. Further complicating decision making is identifying the location for mesh placement as a sublay, onlay, underlay, or bridge. It remains controversial as to whether a component separation should be performed and if fascial releases are contemplated the reconstructive surgeon has a multitude of layers of the abdominal wall to release (1).

The importance of a common language for surgeons repairing ventral hernias cannot be emphasized enough. The creation of staging systems in oncology has allowed physicians to standardize approaches to each type of cancer. This standardization has improved outcomes, unified surgical approaches, and established a language for communication among all physicians that enhances the multidisciplinary approach. Maybe most importantly, the staging system provides a straightforward language for patients to understand their options and prognosis. Hernias may be a different disease process than cancer, but their impact on the healthcare system is still great as it is one of the most common operations performed by surgeons and a staging system can ultimately help tailor operative approaches for ventral hernias and likely improve outcomes for patients. The ventral hernia staging system was first reported by Petro et al. (2). It emphasizes features of the European Hernia Society but also includes aspects of the Ventral Hernia Working Group (VHWG) and establishes a staging system based on hernia width and level of surgical field contamination.

The ventral hernia staging system has three stages: Stage I includes ventral hernias that are less than 10 cm in width and are a CDC clean wound class. This stage generally has a low risk of surgical site occurrence and hernia recurrence quoted at around 10 % for both. Stage II includes hernias that are either 10–20 cm wide and a clean wound class or less than 10 cm wide and a contaminated wound class. A contaminated wound class in this staging system is any nonclean wound class regardless of whether it is CDC wound class 2, 3, or 4. Stage II hernias have an intermediate risk of surgical site occurrence (20 %) and hernia recurrence (15 %). Finally, Stage III includes hernias that have a hernia width greater than 20 cm and are clean surgical fields or any contaminated hernia with a hernia width greater than 10 cm. These hernias have high risks of surgical site occurrence and recurrence, 42 % and 26 %, respectively. This staging system is easy to follow and can be anticipated preoperatively based on clinical scenarios which ultimately should inform discussions with patients and allow surgeons to optimize their operative approach.(1).

Operative Approach Based on Ventral Hernia Stage

One of the most significant challenges in hernia repair is not the operation itself but rather surgical judgment on selecting the most appropriate approach for each patient. This concept of tailoring one's operative approach based on each individual clinical scenario is gaining traction; however, it currently has limited data to help surgeons make decisions in each scenario. Deciding on an operative approach takes into account surgeon preference, patient preference, and patient and hernia characteristics. Some would argue that currently the greatest influence on operative decision making is surgeon preference and comfort with the technique. Utilizing a staging system to decide on operative approaches should not ignore a surgeon's clinical experience but rather act as a general guideline (1).

Management of Stage I ventral hernias provide the most versatility with regards to the various techniques available. As a general concept, Stage I hernias should have closure of the midline fascia and synthetic mesh reinforcement with limited exceptions. Exceptions to the use of mesh include primary umbilical hernias less than 2 cm, patients of childbearing age who anticipate further child bearing, and patient preference to avoid mesh (1).

For patients who are felt to be at increased risk of surgical site occurrence, however, are Stage I ventral hernias, it is recommended that they have macroporous, lightweight, monofilament synthetic mesh placed in a sublay (retromuscular) position. This approach utilizes a synthetic mesh with properties that are most resistant to bacterial contamination.(3) and places mesh in a position with complete tissue apposition while keeping it away from the bowel but below the fascia and protected from superficial surgical site infections. Stage I hernias in patients without comorbidities or obesity and smoking can also be approached as an open onlay technique. This approach can be combined with an anterior component separation to achieve midline fascial closure for larger defects. However, the wound morbidity associated with skin flap creation should limit the utilization of this approach for any patient at high risk for wound complications. In those patients we recommend a retromuscular approach with a posterior component separation if necessary.

Alternatively, minimally invasive ventral hernia repair, with laparoscopy or robotic assistance, is an option for Stage I ventral hernias while maintaining the concept of midline closure and mesh reinforcement. We typically reserve a minimally invasive approach for those patients with hernia defects less than 6 cm in maximal width and without hostile abdomens or excessive scars that need revision (3).

Stage II ventral hernias are larger than Stage I hernias and can involve the presence of contamination and as such have higher rates of surgical site occurrence and hernia recurrence. Multiple factors should be considered when determining one's approach to repair of these hernias. These hernias are almost always best approached with an open rather than a minimally invasive approach for two reasons. First, tissue separating mesh with its anti-adhesive barrier should not be used in contaminated fields. As a result, defects that would have been amenable to laparoscopy because they are less than 10 cm are no longer candidates because of mesh selection. Importantly, it's not that synthetic mesh with appropriate mesh properties cannot be used in contaminated cases but rather that tissue separating barriers on synthetic meshes may provide a favorable environment for bacterial colonization and mesh infection. Secondly, large defects (>10 cm) are likely to require components separation to achieve medialization of the rectus muscles and recreation of the line alba. There have been recent descriptions of minimally invasive components separation such as the endoscopic and robotic transversus abdominis releases with closure of midline defects; however, few of these have been in hernias greater than 10 cm and long-term results are lacking. As a result, currently these patients should be approached with an open operation unless one has advanced training in abdominal wall reconstruction and minimally invasive surgery.(3)

Retrorectus Hernia Repair and Transversus Abdominis Release

Modern hernia surgery has placed great emphasis on functional reconstruction of the abdominal wall, relying on the foundations of tissue-based, tension-free repair along with the latest technologies in mesh reinforcement. Retromuscular hernia repair, as originally described by Rives and Stoppa, has gained significant traction in the recent surgical era.Coupled with the principles of giant prosthetic reinforcement of the visceral sac from Wantz,the retrorectus, Rives–Stoppa–Wantz, technique was declared the gold standard for midline incisional hernia repair by the American Hernia Society in 2004. Despite the benefits offered, there are two major shortcomings of retrorectus-only repair, namely limited myofascial advancement and a limited area for sublay mesh placement, specifically within the confines of linea semilunaris. To address these limitations, a number of modifications have been developed in an effort to further improve the technique. Anterior component separation (ACS), as described originally by Ramirez in 1990 has been widely utilized to gain myofascial advancement, however the subcutaneous flaps raised to perform the external oblique release remains associated with significant wound morbidity.(4)

Further techniques including perforator sparing ACS, endoscopic component separation, and pure preperitoneal repair have attempted to address such issues with variable adoption by surgeons.

Among the various options in the surgical armamentarium, posterior component separation via transversus abdominis release (TAR).(5)continues to gain popularity worldwide since its introduction by Novitsky et al. (5) at the World Hernia Congress The technique offers major benefits for complex hernia patients while addressing the limitations of retrorectus only hernia repair. TAR allows not only significant myofascial advancement, but also creation of a large retromuscular sublay space for mesh implantation avoiding contact with peritoneal contents and subcutaneous tissue. These two principles are central in the Rives–Stoppa repair, however, expanded to fit an ever-challenging populace with large complex hernias.

Indications

Patient selection remains an integral component to success for any surgical procedure. The variability in hernia and patient characteristics demands a tailored approach to repair, rather than a "one size fits all" mentality. Two major branch points arise when determining the appropriate use of retrorectus techniques: first is the determination between a minimally invasive approach and open, and second the use component separation techniques versus traditional Rives–Stoppa repair (6).

In addressing the first distinction, laparoscopic hernia repair should be considered to patients with small to medium defects (defined as <7–8 cm wide), without prior intraperitoneal mesh, and/or overlying skin changes, skin grafts, or wounds healed by secondary intention. For patients with larger defects, the use of minimally invasive approaches results in increased difficulty with obtaining adequate mesh overlap and suboptimal cosmesis. Often, despite adequate mesh overlap, the inability to complete defect closure laparoscopically may result in an undesirable bulge following successful repair. With the recent advent of robotic and laparoscopic abdominal wall reconstructions, the above algorithm is evolving.(6)

Once the retrorectus approach is decided upon, the next distinction to be made is whether the hernia requires a traditional retrorectus Rives–Stoppa repair or posterior component separation via TAR. For smaller (about 6–10 cm) defects where adequate mesh overlap can be obtained within the confines of the rectus sheath, laterally delineated by linea semilunaris, a repair without component separation is adequate.(5)

For complex patients with larger defects, beyond 10cm,Novitsky recommended the TAR approach to be utilized. Importantly, this also includes patients who are not candidates for anterior component separation such as those with subcostal or Chevron incisions, previous ACS, prior appendectomy incisions, or those with a history of abdominoplasty. Additionally, patients with uncommon hernia locations including large subxiphoid, parailiac, and suprapubic hernias may also be best suited for PCS via TAR.(7)

The effectiveness of retromuscular hernia repair has been shown in many patient populations with widely different hernia presentations.(1, 7, 8)

Only a few scenarios exist where TAR should not be employed; chief among this is a pairing of the technique with ACS during the initial operation. Concomitant anterior and posterior component separations will result in a destabilization of the lateral abdominal wall via a disconnection of the major components of linea semilunaris aside from the internal oblique. Interestingly, in the absence of optimal alternatives, use of the TAR procedure for recurrences after prior ACS can be performed with an understanding and acceptance of potential lateral abdominal wall laxity. Other relative contraindications include previous dissection in the retromuscular plane including pre- peritoneal and/or retrorectus repairs, need for concurrent panniculectomy/abdominoplasty, and history of severe necrotizing pancreatitis due to scarring in the retroperitoneum.(8)

Technical Description

As the TAR technique is a continuation/modification of the retrorectus Rives–Stoppa repair, the technical description is given in two parts: a description of the "pure" retrorectus-only Rives–

Stoppa repair and the TAR technique as a separate continuation after the retrorectus dissection is completed (8).

Retrorectus Hernia Repair (Rives-Stoppa Repair)

Most commonly, the operation begins with a midline laparotomy and adhesiolysis. Modifications such as elliptical incisions to encompass previous scars as well as all attenuated or ulcerated skin should be performed when necessary. Often in the morbidly obese with large midline hernias, excision of the umbilicus is performed to minimize postoperative wound morbidity. Adhesiolysis, especially of those to the lateral abdominal wall, is essential as these can limit myofascial medialization, cause peritoneal/posterior sheath tears during myofascial release/advancement, or increase the risk of injury to adherent bowel during retromuscular dissection. Lysis of inter-loop adhesions can be performed judiciously based on the patient's symptomatology. Complete inter-loop adhesiolysis is often unnecessary and serves only to increase operative time. Once adhesiolysis is completed, a countable white/blue towel is placed on top of the viscera with extension into the paracolic gutters, pelvis, above the liver, and towards the esophageal hiatus. Complete exclusion of the viscera from the immediate operative fields serves to protect the peritoneal contents during the hernia repair itself (8).

Once the peritoneal contents are isolated, attention is turned to the retrorectus dissection. Incision into the posterior sheath is made approximately 0.5–1 cm from the edge of the rectus muscle. It is important to identify the muscle either visually or by palpating the muscle belly. This step is critical in patients with large defects and associated loss of domain, where the rectus muscles are retracted laterally. Otherwise, the initial incision may be made incorrectly into the hernia sac, which if divided can result in entry into the subcutaneous plane rather than the retromuscular one. To further alleviate this risk, the initial incision should be attempted either above or below the hernia defect (if possible), where the rectus muscles are more near their native position. Once the muscle edge is identified however, the incision is carried deep until the muscle fibers are visualized clearly. It is important to ensure the correct anatomic location prior to carrying the incision along the length of the rectus towards cephalad and caudad extremes (8).

Once the edge of the posterior rectus sheath is freed from the rectus muscle, constant tension should be utilized to facilitate development of the retrorectus space. This is achieved with a combination of Kocher clamps placed onto the muscle/anterior fascia with constant superior tension and Allis clamps, which are placed on the posterior rectus sheath so that tension may be applied perpendicularly towards the operating surgeon. These clamps should be moved along with the dissection as it progresses to maintain opposing tension. If further superior tension is needed for separation of the posterior sheath, Richardson retractors can be placed along the muscle belly with retraction up and towards the assistant. To develop the retrorectus space, a combination of blunt dissection and electrocautery can be used. Cautery is specifically used to divide the finer areolar tissue and to dissect the small perforating branches of the epigastric arteries, to keep them with the rectus muscle. The retrorectus space is developed towards the linea semilunaris, but importantly, just medial to this boundary as defined by the perforating neurovascular bundles. The neurovascular structures to the recti emerge from the transversus abdominis plane after piercing the posterior lamina of the internal oblique aponeurosis. The cephalad extent of the dissection is the costal margin and may extend to the xiphoid process in the midline depending on the hernia.

The caudal extent is defined by the space of Retzius bilaterally with exposure of the pubic symphysis and Cooper's ligaments (8).

Once the retrorectus space is developed bilaterally, both leaflets of the posterior sheath can be closed with a running 2-0 braided absorbable suture. At this point, an appropriately sized mesh can be placed as a retromuscular sublay within the confines of both linea semilunaris. Once the mesh is in appropriate position, fixation can be performed with transfascial #1 absorbable monofilament suture using a suture- passer and to Cooper's ligaments bilaterally. The number of sutures used for fixation remains largely based on surgeon preference with some surgeons arguing for multiple points to distribute tension evenly, while others try to optimize the balance between fixation points and potential for pain (8).

Once the mesh has been placed, closed suction drains are placed ventral to the mesh and the anterior rectus fascia is re-approximated with a running #1 absorbable monofilament suture. The remaining soft tissue should be closed in layers and any redundant or attenuated skin and soft tissue should be excised to minimize wound complications. If there are large subcutaneous pockets remaining following layered closure, additional subcutaneous drain(s) are utilized. The skin is closed with a running suture or staples.(7)

The Transversus Abdominis Release Procedure

The TAR procedure is a continuation/modification of the traditional retrorectus-only Rives–Stoppa repair. As such, its steps begin once the retrorectus dissection is completed. The dissection is begun with electrocautery and the ventral surface of the posterior sheath (the posterior lamina of the internal oblique) is scored just medial to the perforating neurovascular bundles along the length to cephalad and caudad extremes. This should expose the underlying transversus abdominis muscle and aponeurosis. If this incision is made too medially, one may not encounter the muscle and instead create a fenestration in the peritoneum. Once the muscle is identified in the cephalad region, the fibers are isolated with a right-angle clamp and divided with cautery. This should be done carefully to ensure no inadvertent fenestrations are made in the underlying peritoneal layer. The medial edge of the muscle is divided along its length. In the cephalad portion, the costal margins denote the lateral extent of the dissection. The correct retromuscular plane is dorsal to the ribs. After complete division of the transversus, a right angle clamp is placed onto the lateral cut edge of the muscle to provide retraction and tension. Again, Allis clamps are placed onto the posterior sheath with perpendicular retraction towards the operating surgeon helps provide counter-traction. Then the retromuscular plane is developed bluntly by separating the muscle from the underlying peritoneal layer. This dissection is relatively avascular and any significant bleeding should raise concern that entry into the intramuscular plane has been made. The preperitoneal/pre-transversalis plane can be developed laterally until the lateral edge of the psoas muscle is encountered, although this is not necessary for all cases. The lateral edge of the psoas can be used to help define the space of Retzius and Bogros when moving in a lateral to medial manner. Alternatively, dissection can be done medial to lateral which involves dissection of Cooper's ligaments bilaterally and traveling laterally across the myopectineal orifice. During this dissection, care should be taken to identify neurovascular structures in order to prevent injury. Additionally, in the caudad portion, special attention should be paid to keep the transversalis fascia with the rectus muscle and not with the peritoneum. Staying in the purely preperitoneal plane rather than the pre-transversalis plane will avoid injury to the epigastric vessels. Finally, in female patients the round ligament should be identified and divided. In male patients, the spermatic cord should be isolated and dissected similar to a laparoscopic inguinal hernia repair .(7)

The superior dissection poses some unique challenges based on the extent of the hernia. For hernias with cephalad extension to the epigastric area, dissection must occur in the retrosternal space to ensure adequate mesh overlap. In these cases, the linea alba is divided to the extent of the xiphoid during laparotomy and retrorectus dissection extends into the retrosternal space. It is important to identify the subxiphoid fat pad during this dissection, as it is an indication of the correct plane/depth. In this situation the cephalad continuation of linea alba lies ventral to the dissection plane and the leaflets of the posterior sheath are rejoined to form a retrosternal sublay space. Critically, this dissection involves division of the transversus abdominis in the subcostal plane and extension towards the midline. During this dissection, division of the muscle fibers of the diaphragm is possible as they inter-digitate with the transversus abdominis. If care is not taken to spare the diaphragmatic fibers, entry into the thoracic cavity is possible, effectively creating an iatrogenic Morgagni hernia. Hernias, which extend less cranially (to supra-umbilical area), require connection of the retrorectus planes across the midline below the subxiphoid region. This allows adequate sublay space for mesh placement, thus reducing the risk of recurrences superior to the mesh. To perform this dissection, the contribution of the posterior sheath to the linea alba is incised approximately 0.5–1 cm laterally on each side. The leaflets of the posterior sheath are re-approximated during closure, again with 2-0 braided absorbable suture. .(7)

Once component separation is completed superiorly, inferiorly, and laterally any fenestrations in the posterior rectus sheath are closed in a transverse manner, if possible, to alleviate tension, using a 2-0 braided absorbable suture. Closure of the posterior sheath is generally begun at cephalad and caudad ends separately, again using the 2-0 braided absorbable suture in a running fashion towards the middle. The closure is similar to the traditional Rives–Stoppa repair in this regard. In cases where myofascial advancement still fails to restore the posterior sheath, the patient's own native tissue or a bridging absorbable mesh may be utilized to span the gap. Every attempt should be made at complete restoration of the visceral sac as it reduces the risk of intra-parietal hernias (between the layers of the abdominal wall) and prevents contact between peritoneal contents and the reinforcing mesh. If there is significant tension in closure of the anterior sheath despite TAR, interrupted figure-of-eight sutures can be used to close the anterior fascia. Large closed suction drains are placed above the mesh and the remaining soft tissue is closed in layers. The same principles of skin/soft-tissue excision are utilized following TAR and the skin is closed in a running fashion or with staples.(7)

Outcomes

A single methodology for ventral hernia repair is not ideal for all patients or hernia presentations. Although the search for the "ideal" technique and mesh is ongoing, retrorectus hernia repair and TAR have proven efficacy in a wide variety of patients. The traditional Rives–Stoppa repair has a long-proven record of accomplishment with multiple database studies evidencing recurrence rates between 7.3 and 12.1 %.(9) Furthermore, the initial series of 42 patients undergoing TAR was published in 2012, with 24 % rate of wound events and only 4.7 % recurrences at a median follow-up of over 2 years.(10)

Recently, in the series of 428 patients under-going TAR with synthetic mesh reinforcement, study demonstrated 9.1 % surgical site infections (including contaminated repairs), and a 3.7 % recurrence rate with a mean follow-up of 31.5 months.(7)Furthermore, the use of TAR has been demonstrated in a variety of complex patient populations including hernias following trauma with open abdomens, kidney transplant patients, and patients requiring repair following previous anterior component separation with favorable results. Retromuscular hernia repair with posterior component separation via TAR provides a safe and durable method for complex hernia repair.(2, 8)

Despite favorable clinical results, however, there is pertinent ongoing discussion on the potential deleterious effects of TAR. As the transversus abdominis is responsible for both maintenance of circumferential abdominal tension and generation of tension in the thoracolumbar fascia, concern about the effects on abdominal wall and spine stability were raised. Further investigation into the physiology of the abdominal wall following TAR demonstrated both rectus muscle hypertrophy and compensatory hypertrophy of the external and internal oblique muscles.(11) A clinical functional study utilizing dynamometry evidenced an improved core functionality following TAR as well. Available data have clearly addressed some of the initial skepticism and concern regarding division of the transversus abdominis muscle.(12)

Redivision of the posterior rectus sheath medial to the linea semilunaris and the perforating neurovascular bundles. Exposed is the underlying transversus abdominis muscle, which inserts medially onto the posterior rectus sheath.(13)

Anterior Component Separation Techniques

`Principles of ventral hernia repair include patient optimization, judicious tissue dissection, and fascial defect closure with the use of prosthetic materials for reinforcement.(14) Incisional hernia repair without mesh has unacceptable results with recurrences in more than 50 % of patients while the use of mesh may reduce recurrence rates by nearly 50 %. (15)While a mesh herniorrhaphy alone is appropriate in the majority, patients with complex hernias often require tissue advancement to restore the abdominal wall successfully. This requires re-establishment of physiologic abdominal wall tension and dynamics, allowing improved wound healing and decreased ischemic complications.(16, 17)

Component separation technique, also known as separation of parts, relies on physical characteristics of the abdominal wall to increase mobility. The abdominal wall is composed of overlapping muscle layers able to be separated while maintaining vascularization and innervation. By dissecting out muscle layers, the mobilization of individual units becomes greater than the mobilization of the unit as a whole (18)This allows for greater advancement of the abdominal wall and improved approximation of each side (17)

The relatively avascular plane located between the external and internal oblique makes this separation possible, and a total of 10 cm of advancement on each side can be obtained. However, the internal oblique and transversus abdominis muscle should not be separated due to the segmental neurovascular bundles of the rectus muscles and the sensory branches of the middle and lower abdomen, groin, and scrotum located in that plane.(18)

Ideally, mobilization and approximation of the rectus- internal oblique-transversus abdominis flap will allow for primary facial closure. In giant ventral hernias, however, component separation technique can be insufficient to completely close the defect. In such cases, bridging mesh may be required, although this is unusual. While not ideal, component separation with bridging provides more reliable hernia closure than bridged repair alone (14) The adjunct of the component separation will further minimize the size of the defect and result in a smaller area for the bridging mesh. However, even when primary fascial closure is obtained, mesh reinforcement of the abdominal wall is still advised (17)

Since the time of the landmark publication of the component separation technique by Ramirez et al., numerous modifications have been described. The three main component separation techniques in existence today are the open anterior component separation technique, the perforator preserving (or sparing) technique, and the endoscopic technique. In each procedure, the goal is to separate abdominal muscle layers to achieve greater wall mobility. The differences lie in the methods used to achieve that end with associated reduction in wound complications through avoidance of undermining skin flaps. Still, each technique remains relevant, as each technique may be best suited for individualized patient scenarios (17).

Open Anterior Components Separation Technique

Ramirez et al. initially described the dissection of the abdominal wall into components for mobilization of the rectus abdominis complex to allow for closure of complex abdominal wall defects. The procedure was hailed as the solution to high recurrence rates seen in previous procedures. However, the technique quickly fell out of favor due to high rates of surgical site occurrences including seroma, hematoma, and infection.(18)

A recent resurgence of the open component separation technique has occurred due to an increasing interest in restoring abdominal wall function, achieving physiological tension, and maintaining abdominal wall dynamics, which are characteristics achieved utilizing component separation techniques.(19)

The Ramirez component separation technique is frequently utilized in the repair of complex abdominal wall hernias due to the relatively short learning curve associated with the technique.(19)Reported indications for the Ramirez component separation technique include high-risk elderly populations, patients with a history of multiple prior abdominal surgeries, and large abdominal wall defects where maximal advancement is required.(20)The Ramirez component separation technique has been widely reported and provides if or maximal abdominal wall advancement through the creation of large undermining skin flaps, separation of the posterior rectus sheath from the rectus abdominis muscle, and open separation of the external oblique from the underlying internal oblique muscle. Each component of the operation results in increasing advancement of the abdominal wall, and the combination of each of the three elements when performed bilaterally may allow for closure of abdominal wall defects nearly 20 cm in width.(21)

Evolution

Prior to the initial description of the component separation technique, ventral hernias were repaired by advancing the abdominal wall as a solitary unit. When closure was not feasible, options included placement of a prosthetic mesh to bridge the defect, skin closure alone over the defect, or utilization of a graft or flap. Bridging mesh was associated with frequent complications due to mesh extrusion.(20) The use of flaps was associated with additional donor site morbidity. The component separation technique significantly reduced hernia recurrence rates while alleviating the need for remote tissue transfer or bridged mesh implantation.(18)

Outcomes

The outcomes for the open anterior compartment separation technique demonstrate significant improvements over prior ventral hernia repair techniques. Prior outcomes of tensor fascia latae flap translocation and closure resulted in recurrence rates as high as 42 % compared to the 16 % recurrence seen in open component separation. Still, the component separation technique has higher recurrence rates compared to its subsequent evolutionary techniques, the perforating preserving and endoscopic component separation procedures which are discussed later. Furthermore, the component separation technique results in high rates of surgical site occurrences when compared to perforator preserving techniques, endoscopic techniques, and other traditional hernia repair techniques.(14, 22)

Surgical site occurrences associated with component separation technique include seroma, abscess, hematoma, cellulitis, surgical site infection, and skin necrosis.(14, 22)Although open component separation technique is often associated with longer hospital stays, operating room times are generally shorter and there is no need for any specialized equipment compared to other techniques, unlike laparoscopic approaches.(21)

Challenges and Pitfalls

The open component separation technique requires creation of large lipocutaneous flaps, resulting in division of the epigastric perforating vessels (providing vascularity to the central abdominal wall skin), creation of dead space, and wide undermining of subcutaneous tissue.(20, 23)

While this may be well tolerated in select patients, this may be attributed to the surgical site complication rate seen with the technique. The loss of epigastric perforating vessels leaves skin flaps vascularized by only the intercostal arteries and branches of the pudendal artery.(22)This co-lateral flow may be insufficient to maintain viability, resulting in skin necrosis. Other challenges to the procedure include the risk of lateral herniation. Caution while dissecting the superficial layer of internal oblique fascia is paramount as deep dissection can damage segmental innervation of the rectus abdominal muscle or injure Spigelian fascia, increasing the risk for incisional complications and lateral hernias. Despite drawbacks, the open component separation technique offers many advantages and allows for a robust abdominal wall closure in appropriately selected patients.(21, 23)

Perforator Preserving Component Separation Technique

Overview

The perforator preserving open component separation technique evolved as a result of the wound morbidity which occurred in patients undergoing the open anterior approach. During open component separation, subcutaneous tissues are dissected laterally to reach the aponeurosis of the external oblique muscle. This widely dissected lipocutaneous flap extending from costal margin to pubic bone relies on the intercostal arteries for vascularity. Patients with compromised vascularity to the abdominal wall from prior retroperitoneal incisions, obesity, or vascular disease may be more likely to develop postoperative ischemic wound complications from a traditional anterior component separation. The perforating preserving technique improves upon the open method by reducing subcutaneous dead space and avoiding transection of perforator vessels.(24)

In the perforating preserving component separation technique, first presented by.(25)and modified by.(26) and later.(24)the epigastric perforator vessels are salvaged by avoiding the 3 cm radius around the umbilicus. The perforating vessels which supply the anterior abdominal wall skin are typically located in the periumbilical region and arising from the deep epigastric vessels. Maintaining these perforating vessels helps preserve vascularity to the lipocutaneous flap. The procedure optimizes pulsatile blood flow to the abdominal wall skin, thus improving wound healing without compromising the benefits of the procedure(26)

Evolution

As first described, the perforator preserving technique was performed through separate transverse incisions placed on the lateral abdominal wall.(25) This incision was made through skin, subcutaneous tissues, and the external oblique fascia to expose the space between the internal and external oblique muscles. A balloon dissector is placed below the external oblique muscle and above the internal oblique muscle to dissect this “inter-oblique” space. Following removal of the balloon, under video-endoscopic control, the external oblique aponeurosis is incised lateral to the linea semilunaris extending from the inguinal ligament to the costal margin. This results in a well-vascularized compound flap that can be advanced to the midline. This technique requires the use of balloon dissectors and video-endoscopic equipment to expose the external oblique muscle and aponeurosis through this 2–4 cm lateral incision.

Numerous other techniques have been developed since Maas’ initial description of an endoscopically assisted component separation technique.(26)

Outcomes

There are limited studies comparing the perforator preserving component separation technique to either the open or endoscopic techniques. However, it is clear the perforator preserving technique lowers surgical site occurrences when compared to open component separation. In one study, the perforator preserving method had a 27 % wound complication rate compared to the 52 % wound complication rate associated with the open procedure. This can likely be attributed to successful preservation of the epigastric perforating vessels and the subsequent reduction of skin necrosis. However, the creation of the subcutaneous tunnels may be technically difficult due to the limited exposure and visualization of the external oblique. But the simplicity of the dissection, which requires only a retractor and a Yankauer suction tip to expose and divide the external oblique, adds to the appeal of this approach.(27)

The operative time required to perform the dissection may be increased with a perforator preserving component separation relative to an open component separation, but the reduction in postoperative complications more than makes up for the modest increase in intra-operative time.(21)

While adverse outcomes for the perforating preserving technique are decreased compared to the open compartment separation technique, the learning curve is steep. Variability in outcomes can be anticipated as surgeons develop experience with the technique.(19)

Challenges and Pitfalls

The perforator preserving technique can be challenging to perform. Creating tunnels through the midline requires a generous tunnel to provide adequate visualization of the external oblique aponeurosis. Placement of additional incisions on the lateral abdominal wall may facilitate this exposure in obese patients or in cases with significant retraction of the lateral abdominal wall musculature (19).

There are typically four or five pairs of perforating vessels that are located in the periumbilical region. Direct dissection and visualization of the perforating vessels should generally be avoided so as to avoid inadvertent injury, traction injury, or thrombosis. It is advisable to avoid dissection of the subcutaneous tissues for several centimeters above and below the umbilicus. While the majority of vessels are located in the periumbilical location, occasionally additional vessels are encountered. Any dominant vessel should be preserved when feasible (19).

Anterior component separation technique. The external oblique muscle was incised up to the external fascia of the internal oblique muscle, leaving the internal oblique muscle intact. Blunt dissection was performed for medialization of the anterior and posterior rectus sheath.(28) Modified “components separation” technique using bilateral transverse subcostal incisions to access the external oblique muscle and fascia. A, using anarrow Deaver retractor and a Bovie cautery with an extender, the external oblique muscle and fascia are divided superiorly (above the rib cage) and inferiorly. B, At the caudal aspect of the midline incision, the cut edge of the external oblique muscle and fascia is delivered using manual traction for complete release.(29).

References:

1. Petro, C. C., O’Rourke, C. P., Posielski, N. M., Criss, C. N., Raigani, S., Prabhu, A. S., & Rosen, M. J. (2016). Designing a ventral hernia staging system. Hernia, 20(1), 111–117. https://doi.org/10.1007/s10029-015-1418-x
2. Petro, C. C., Orenstein, S. B., Criss, C. N., Sanchez, E. Q., Rosen, M. J., Woodside, K. J., & Novitsky, Y. W. (2015). Transversus abdominis muscle release for repair of complex incisional hernias in kidney transplant recipients. American Journal of Surgery, 210(2), 334–339.
3. Krpata, D. M., Blatnik, J. A., Novitsky, Y. W., & Rosen, M. J. (2012). Posterior and open anterior components separations: A comparative analysis. American Journal of Surgery, 203(3), 318–322.
4. Reilingh, T. S. D. V., Van Goor, H., Charbon, J. A., Rosman, C., Hesselink, E. J., Van Der Wilt, G. J., & Bleichrodt, R. P. (2007). Repair of giant midline abdominal wall hernias: “Components separation technique” versus prosthetic repair: Interim analysis of a randomized controlled trial. World Journal of Surgery, 31(4), 756–763.
5. Novitsky, Y. W., Elliott, H. L., Orenstein, S. B., & Rosen, M. J. (2012). Transversus abdominis muscle release: A novel approach to posterior component separation during complex abdominal wall reconstruction. American Journal of Surgery, 204(5), 709–716.

6. Belyansky, I., Zahiri, H. R., & Park, A. (2016). Laparoscopic Transversus Abdominis Release, a Novel Minimally Invasive Approach to Complex Abdominal Wall Reconstruction. Surgical Innovation, 23(2), 134–141.
7. Novitsky, Y. W., Fayezizadeh, M., Majumder, A., Neupane, R., Elliott, H. L., & Orenstein, S. B. (2016). Outcomes of Posterior Component Separation with Transversus Abdominis Muscle Release and Synthetic Mesh Sublay Reinforcement. Annals of Surgery, 264(2), 226–232.
8. Pauli, E. M., Wang, J., Petro, C. C., Juza, R. M., Novitsky, Y. W., & Rosen, M. J. (2015). Posterior component separation with transversus abdominis release successfully addresses recurrent ventral hernias following anterior component separation. Hernia, 19(2), 285–291.
9. Israelsson, L. A., Smedberg, S., Montgomery, A., Nordin, P., & Spangen, L. (2006). Incisional hernia repair in Sweden 2002. Hernia, 10(3), 258–261.
10. Helgstrand, F., Rosenberg, J., Kehlet, H., Jorgensen, L. N., & Bisgaard, T. (2013). Nationwide prospective study of outcomes after elective incisional hernia repair. Journal of the American College of Surgeons, 216(2), 217–228.
11. De Silva, G. S., Krpata, D. M., Hicks, C. W., Criss, C. N., Gao, Y., Rosen, M. J., & Novitsky, Y. W. (2014). Comparative radiographic analysis of changes in the abdominal wall musculature morphology after open posterior component separation or bridging laparoscopic ventral hernia repair. Journal of the American College of Surgeons, 218(3), 353–357.
12. Criss, C. N., Petro, C. C., Krpata, D. M., Seafler, C. M., Lai, N., Fiutem, J., Novitsky, Y. W., & Rosen, M. J. (2014). Functional abdominal wall reconstruction improves core physiology and quality-of-life. Surgery (United States), 156(1), 176–182.
13. Petro, C. C., Como, J. J., Yee, S., Prabhu, A. S., Novitsky, Y. W., & Rosen, M. J. (2015). Posterior component separation and transversus abdominis muscle release for complex incisional hernia repair in patients with a history of an open abdomen. Journal of Trauma and Acute Care Surgery, 78(2), 422–429.
14. Breuing, K., Butler, C. E., Ferzoco, S., Franz, M., Hultman, C. S., Kilbridge, J. F., Rosen, M., Silverman, R. P., & Vargo, D. (2010). Incisional ventral hernias: Review of the literature and recommendations regarding the grading and technique of repair. Surgery, 148(3), 544–558.
15. Luijendijk, R. W., Hop, W. C. J., van den Tol, M. P., de Lange, D. C. D., Braaksma, M. M. J., IJzermans, J. N. M., Boelhouwer, R. U., de Vries, B. C., Salu, M. K. M., Wereldsma, J. C. J., Bruijninckx, C. M. A., & Jeekel, J. (2000). A Comparison of Suture Repair with Mesh Repair for Incisional Hernia. New England Journal of Medicine, 343(6), 392–398.
16. Azoury, S. C., Dhanasopon, A. P., Hui, X., Tuffaha, S. H., De La Cruz, C., Liao, C., Lovins, M., & Nguyen, H. T. (2014). Endoscopic component separation for laparoscopic and open ventral hernia repair: a single institutional comparison of outcomes and review of the technique. Hernia, 18(5), 637–645.
17. Eriksson, A., Rosenberg, J., & Bisgaard, T. (2014). Surgical treatment for giant incisional hernia: A qualitative systematic review. In Hernia (Vol. 18, Issue 1, pp. 31–38).
18. Ramirez, O. M., Ruas, E., & Dellon, A. L. (1990). “Components Separation” Method for Closure of Abdominal-Wall Defects. Plastic and Reconstructive Surgery, 86(3), 519–526.

19. Lisiecki, J., Kozlow, J. H., Agarwal, S., Ranganathan, K., Terjimanian, M. N., Rinkinen, J., Brownley, R. C., Enchakalody, B., Wang, S. C., & Levi, B. (2015). Abdominal wall dynamics after component separation hernia repair. Journal of Surgical Research, 193(1), 497–503.
20. Holihan, J. L., Askenasy, E. P., Greenberg, J. A., Keith, J. N., Martindale, R. G., Roth, J. S., Mo, J., Ko, T. C., Kao, L. S., & Liang, M. K. (2016). Component Separation vs. Bridged Repair for Large Ventral Hernias: A Multi-Institutional Risk-Adjusted Comparison, Systematic Review, and Meta-Analysis. Surgical Infections, 17(1), 17–26.
21. Gonzalez, R., Rehnke, R. D., Ramaswamy, A., Smith, C. D., Clarke, J. M., & Ramshaw, B. J. (2005). Components separation technique and laparoscopic approach: a review of two evolving strategies for ventral hernia repair. The American Surgeon, 71(7), 598–605.
22. Clarke, J. M. (2010). Incisional hernia repair by fascial component separation: Results in 128 cases and evolution of technique. American Journal of Surgery, 200(1), 2–8.
23. Adekunle, S., Pantelides, N. M., Hall, N. R., Surg, G., Praseedom, R., & Malata, C. M. (2013). Indications and Outcomes of the Components Separation Technique in the Repair of Complex Abdominal Wall Hernias: Experience From the Cambridge Plastic Surgery Department.
24. Butler, C. E., & Campbell, K. T. (2011). Minimally invasive component separation with inlay bioprosthetic mesh (MICSIB) for complex abdominal wall reconstruction. Plastic and Reconstructive Surgery, 128(3), 698–709.
25. Maas, S. M., Van Engeland, M., Leeksma, N. G., & Bleichrodt, R. P. (1999). A Modification of the "Components Separation" Technique for Closure of Abdominal Wall Defects in the Presence of an Enterostomy.
26. Saulis, A. S., & Dumanian, G. A. (2002). Periumbilical Rectus Abdominis Perforator Preservation Significantly Reduces Superficial Wound Complications in "Separation of Parts" Hernia Repairs. Plastic and Reconstructive Surgery, 109(7), 2275–2280.
27. Harth, K. C., & Rosen, M. J. (2010). Endoscopic versus open component separation in complex abdominal wall reconstruction. American Journal of Surgery, 199(3), 342–347.
28. Sneiders, D., Yurtkap, Y., Kroese, L. F., Jeekel, J., Muysoms, F. E., Kleinrensink, G. J., & Lange, J. F. (2019). Anatomical study comparing medialization after Rives-Stoppa, anterior component separation, and posterior component separation. Surgery (United States), 165(5), 996–1002.
29. Ko, J. H., Wang, E. C., Salvay, D. M., Paul, B. C., & Dumanian, G. A. (2009). Abdominal Wall Reconstruction Lessons Learned From 200 "Components Separation" Procedures. In Arch Surg (Vol. 144, Issue 11).