Chapter

# Robotic Complex Abdominal Wall Reconstruction: The Evolution of Component Separation

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**Abstract**

From the first description of the component separation technique in the literature at the end of the twentieth century to the current state of complex abdominal wall reconstruction, this rapidly evolving field of General Surgery has advanced at an accelerated pace. With the advancement of technological breakthroughs that stem from the original open technique, endoscopic, laparoscopic, and more recently robotic approaches have been developed to facilitate complex abdominal wall reconstruction to restore the body's anatomy and physiology to functional levels. This chapter will give an overview of the historic progression of these advanced techniques and will illustrate the key steps for their safe and effective performance including the endoscopic external oblique anterior release as well as posterior release techniques such as the robotic transversus abdominis release (TAR). Finally, other useful variations of complex repair such as the robotic extended totally extraperitoneal (eTEP) approach will be described.

**Keywords:** abdominal wall reconstruction, component separation, hernia repair, robotic surgery, minimally invasive surgery

## 1. Introduction

The history of component separation starts at the beginning of the twentieth century, after the advent of general anesthesia in 1846. Thanks to the combined efforts and lessons learned from Charles Gibson, C.F. Dixon, and Donald Young, eventually Oscar Ramirez was able to describe his technique of abdominal fascial release and popularize the modern "component separation" technique.

Early efforts at primary closure of incisional hernias were prone to failure because of poor suture materials, inadequate prostheses, and most importantly, the tension on the repair. It was at the beginning of the twentieth century that Gibson described a method for "plastic repair of the abdominal wall" that involved relaxing incisions on the lateral anterior rectus sheath.

In 1929, Dixon modified Gibson's method and instead released the anterior rectus sheath 0.5 cm from its medial border bilaterally, turning over and opposing these fascial flaps in the midline [1–3].

In 1961, a more complex version of these techniques was described by Young when attempting closure of epigastric hernias, a common complication in the pre-laparoscopic era secondary to large incisions for open cholecystectomies and wound infections. Based on previous descriptions by Gibson and Dixon, Young advised separating the anterior and posterior rectus sheath from the rectus muscle to release the muscle and allow it to move easily to the midline. Next, the lateral border of the rectus sheath was incised a finger's breadth medial to the costal margin in the upper epigastrium and the same distance from the lateral edge of the rectus muscle in the lower epigastrium to reduce tension on the repair.

Ramirez, in his landmark article, described the component separation technique by releasing the external oblique aponeurosis lateral to the lateral edge of the rectus sheath. This is the critical maneuver of releasing the external oblique aponeurosis from the anterior rectus sheath lateral to the semilunar line. In 1990, Ramirez described what is now known as the modern component separation technique. After studying the technique in 10 fresh cadavers and applying the anatomic findings to reconstruct the abdominal wall defect of 11 patients, Ramirez published his technique in the journal of Plastic and Reconstructive Surgery. He described releasing the external oblique muscle through a lateral incision to the semilunar line and separating the external oblique muscle from the internal oblique muscle in a relatively avascular plane.

With the goal of restoring the normal anatomy of the abdominal wall at the midline, Ramirez incised the aponeurosis of the external oblique muscle lateral to the lateral edge of the rectus sheath and performed extensive dissection underneath the external oblique, separating it from the internal oblique muscle. Additionally, the rectus muscle was separated from the posterior rectus sheath at the midline. These dissections allowed the advancement of the "components" of the abdominal wall – the rectus abdominis, the external oblique, the internal oblique, and the transversus abdominis muscles – to the midline, allowing ventral hernia defects of 20 cm to be closed without tension [4].

## 2. Posterior release component separation

In the 1960s, Jean Rives and Rene Stoppa also developed the Rives Stoppa technique for retrorectus mesh repair known as the Rives-Stoppa method. In this repair, extensive dissection is carried out in the space between the rectus abdominis muscle and the posterior rectus sheath to create a space to place the mesh. This allows the rectus abdominis muscle to mobilize more toward the midline, but because the repair is limited by the lateral border of the posterior rectus sheath, it may be inadequate to repair larger hernias [5].

Outside of Ramirez's original description of the component separation, an additional approach to hernia repair was described later by Novitsky in 2012 known as the transversus abdominis release (TAR). This approach is an extension of the Rives-Stoppa technique and has quite a few advantages. The key component of this repair is to release the transversus abdominis muscle itself. There are several advantages to this approach. Release of the transversus abdominis allows medial mobilization of the posterior rectus sheath. The function of the transversus abdominis and posterior fibers of the internal oblique is to provide tension throughout the thoracolumbar fascia and increase abdominal fascia integrity. Therefore, since the muscles are almost circumferential, the dissection allows access to almost unlimited space, as described below. Novitsky described this in detail in his 2012 description [6–8].

After entering the abdomen via laparotomy, the posterior rectus sheath is identified and incised 0.5 to 1 cm medial to the anterior/posterior sheath junction to expose the transversus abdominis. Starting at the level of the umbilicus, the retromuscular place is developed laterally toward the linea semilunaris. During this dissection, the neurovascular bundles penetrating the lateral edge of the posterior rectus sheath can be visualized and must be preserved. The posterior rectus sheath is divided 0.5–1 cm medial from its edge. The retromuscular plan is developed toward the linea semilunaris and then incised in the upper abdomen to visualize the underlying transversus abdominis. The neurovascular bundles that are penetrating the posterior sheath are preserved. The entire length of the transversus abdominis is then incised with electrosurgical energy at its medial edge. This allows entrance to the space above the transversalis fascia. This plane can be dissected to reach the space of Retzius anterior to the urinary bladder, and the subxiphoid space superiorly. The large retrorectus space is closed by closing the posterior sheath with a running monofilament suture, after which a mesh is placed and secured. Of note, in Novitsky's experience, this technique allowed 8–12 cm of advancement per side toward the midline. This technique opened an entirely new plane to repair large abdominal hernias and is really a natural progression of the repairs described before this.

## 3. Minimally invasive TAPP and TEP

When the laparoscopic approach to ventral hernias was first introduced, the techniques described the placement of intraperitoneal underlay mesh later on called intraperitoneal onlay mesh (IPOM). Its implementation has been complicated by adhesive bowel disease, mesh erosion, and enterocutaneous fistulae from direct contact between the mesh and bowel. Due to these complications, a transabdominal preperitoneal (TAPP) approach was described. This technique involved entering the abdominal cavity laparoscopically and developing a preperitoneal/retrorectus space for placement of the mesh.

In 2018, Belyansky described a novel approach for approaching ventral hernia repair using a totally extraperitoneal technique, which previously had been described for laparoscopic inguinal hernia repairs. He called it the enhanced-view totally extraperitoneal (eTEP) technique which is also referred as the extended totally extraperitoneal technique. With this method of repair, laparoscopic ports are placed into the retrorectus space where dissection occurs first in one of the retrorectus spaces and then the contralateral one, which allows for placement of a retrorectus mesh similar to the Rives-Stoppa technique.

With the advent of robotic surgery and the dexterity provided by robotic instruments as compared to laparoscopic instruments, many surgeons have attempted repair of larger and more complex hernias.

## 4. Robotic reconstruction techniques

### 4.1 Robotic IPOM

The patient is placed in the supine position with both arms tucked and secured to avoid any movement during the procedure and to allow room for docking of the robot and avoidance of collision between the patient's arm and the robotic arm. Three ports are placed based on surgeon preference, but typically on the most lateral aspect of the abdominal wall, usually on the left side but not exclusively there. If the hernia is in the midline, these may be placed on either side. Our ports are placed at least 8 cm apart to avoid interference between the arms of the robotic instruments.

After port site selection, we typically gain entry into the abdomen using a 5 mm optical trocar and 0° laparoscope via the optical entry technique. Once pneumoperitoneum is obtained, the other two 8 mm robotic trocars are then placed under direct visualization. The original 5 mm port is substituted by an 8 mm robotic trocar which may be upsized to 12 mm if necessary during the case to introduce the mesh intraperitoneally according to the selected size. A 5 mm accessory port may also be placed to help assist the operative surgeon but is often unnecessary. With large hernia defects or when extensive lysis of adhesions is indicated, an assistant port or the fourth robotic arm may be helpful to aid in tissue retraction and facilitate a safe and timely dissection. The robot is then docked, and robotic instruments are introduced under direct visualization.

The first step in the procedure is adhesiolysis, if indicated. The difficulty varies from case to case depending on hernia size, chronicity, and prior procedures. Adhesions are taken down using a combination of blunt and sharp dissection. Electrosurgical energy may also be used at the surgeon's discretion, but care must be taken to avoid thermal injury to any vital structures contained in the hernia sac such as the intestine. The hernia contents are reduced back intraperitoneally, and inspection of the contents is done to confirm no damage has been done to any of the contents and further hemostasis is achieved. The fascial defect is then measured. Insufflation is reduced before measuring the defect to prevent overestimation of the hernia defect.

If feasible, the fascial defect is closed primarily. In our practice, we typically perform this in a continuous fashion using a permanent barbed suture. First, we bring down the insufflation from 15 to 8 mm Hg to reduce any tension on the primary closure. A non-absorbable barbed suture is introduced intraperitoneally. The fascia is then closed in a continuous fashion, although this could be done in an interrupted fashion per surgeon preference.

The next step is the placement of the mesh. Per the current literature, a 4–5 cm mesh overlap is recommended for ventral hernia repairs. After appropriate mesh selection, the mesh is rolled up extracorporeally and then introduced into the cavity using a 12 mm port. The mesh is then oriented so that it can overlap 4–5 cm circumferentially around the defect. The overlap is important due to future contraction of the mesh that occurs during the healing phase, which can lead to re-emergence of the defect and increased risk of hernia recurrence.

Once the mesh is in the appropriate position, fixation can be achieved by multiple methods as in laparoscopic surgery. These include intracorporeal suturing and tacking with different products. An advantage of the IPOM repair from a robotic approach is that the mesh can easily and reliably be fixated utilizing intracorporeal suturing due to the improved visualization, ergonomics, and dexterity that is achievable in robotic surgery. In our practice, the mesh is sutured using a non-absorbable monofilament barbed suture in a continuous, running fashion. Multiple sutures may need to be used depending on the size of the mesh. This is based on surgeon preference, but it may also be fixated in an interrupted fashion.

After the mesh has been placed, the abdomen is once again inspected to ensure hemostasis. The robotic instruments are removed under direct visualization and the robot is undocked. The 12 mm port is removed first, and the abdomen is desufflated to 8 mm Hg to reduce tension on the fascia. The fascial defect is closed primarily in a simple interrupted fashion using 0-Vicryl suture on a suture passer. The gas is turned off and the abdomen is desufflated followed by removal of the remaining ports. The skin is then closed using 4-0 Monocryl in a subcuticular fashion and Dermabond is applied over the skin closure sites [9–14].

### 4.2 Robotic IPOM with endoscopic anterior component separation

Another described technique for hernia repair is the endoscopic anterior (external oblique) component separation with robotic hernia repair. This procedure involves a two-stage approach.

In the first stage, an anterior component separation is performed on the external oblique aponeurosis endoscopically with laparoscopic instruments. Ports are placed lateral to the semilunar line. The space between the external and internal oblique aponeuroses is entered using a cut-down approach with sharp and blunt dissection. An intramural plane is initially dissected between these structures using a finger followed by a balloon spacer. Laparoscopic trocars are placed bilaterally. The laparoscope and monopolar scissors are then used to visualize and further dissect this plane to perform an open anterior component separation on the external oblique aponeurosis lateral to the semilunar line.

The second stage of the operation involves entering the peritoneal cavity via the optical trocar technique to carry out a robotic reduction and closure of the hernia defect as described above in the IPOM technique section. By performing endoscopic component separation before IPOM, primary repair of the defect before mesh placement is easier as these fascial planes have been released [15–17].

### 4.3 Robotic eTEP

The robotic retrorectus flap creation achieved with an extended totally extraperitoneal (eTEP) approach offers multiple advantages including the development of a tension-free repair, the lack of contact between the mesh and the underlying intraperitoneal viscera, and the position of the mesh in the preperitoneal plane, which eliminates the risk of future adhesion formation. The patient is placed in a supine position. Arms are tucked loosely to allow them to drift slightly posterior. This allows for an additional range of motion for the robotic arm to prevent the patient's arm from colliding with it. This also ensures that the superior-most port does not collide with the patient's arm when placed out laterally. Care is taken not to hyperextend the shoulder during positioning. Due to this positioning, one can also perform transversus abdominis release if necessary, from either side of the patient without having to reposition them.

Optical entry is performed in the left upper quadrant medial to the semilunar line by using a 5 mm optical entry port with care not to penetrate the posterior rectus sheath to avoid entering the peritoneal cavity (**Figure 1**). The posterior rectus sheath is visualized, and blunt dissection is carried out to develop this plane for subsequent insufflation. Pneumopreperitoneum is established to continue to develop the left retrorectus space ideally with an Airseal insufflation system to prevent loss of insufflation if a small defect is created accidentally on the posterior rectus sheath (**Figure 2**). A small amount of blunt dissection is carried out to enable placement of a second 5 mm port (Airseal) inferior to the initial port.

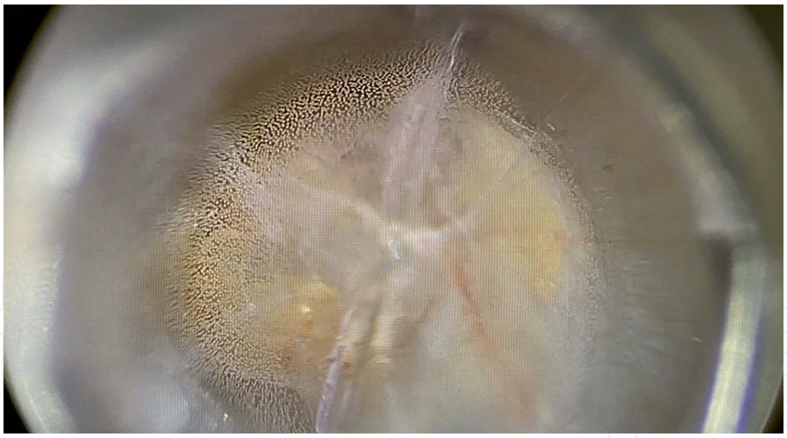

**Figure 1.**
*Optical entry into the left retrorectus space.*

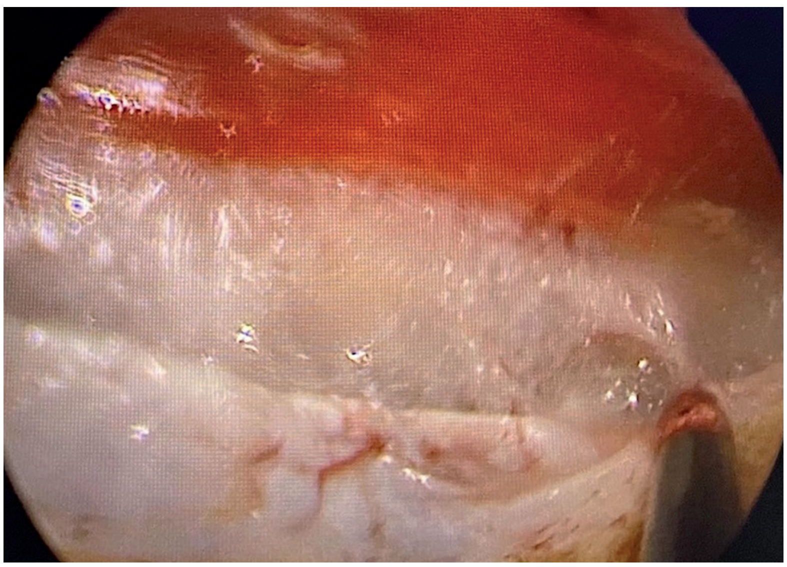

**Figure 2.**
*Endoscopic development of left retrorectus flap.*

Endoscopic dissection of areolar tissue with laparoscopic instruments including the monopolar electrosurgical hook is carried out superiorly/inferiorly and across the midline in the epigastric region by dividing the medial aspect of the left retrorectus space and crossing over to the right retrorectus space over the linea alba (**Figure 3**). During this step, rectus diastasis becomes obvious with this crossing-over maneuver to the right retrorectus space. This step is necessary to insert three 8 mm robotic trocars in a horizontal line disposition across the upper abdomen (**Figure 4**). One of these trocars can be upsized later to 12 mm to introduce the mesh. On the other hand, robotic trocars may be placed either superiorly or laterally depending on the desired approach and location of the hernia defect. If one is planning on performing an extensive transversus abdominis release (TAR) in addition to hernia repair via the eTEP approach, we recommend a superior port placement so that the bilateral TAR can be performed from the same port position without having to re-dock.

Continued dissection is carried out using monopolar electrosurgical energy with the robot to form a retromuscular plane of dissection around the hernia sac. One

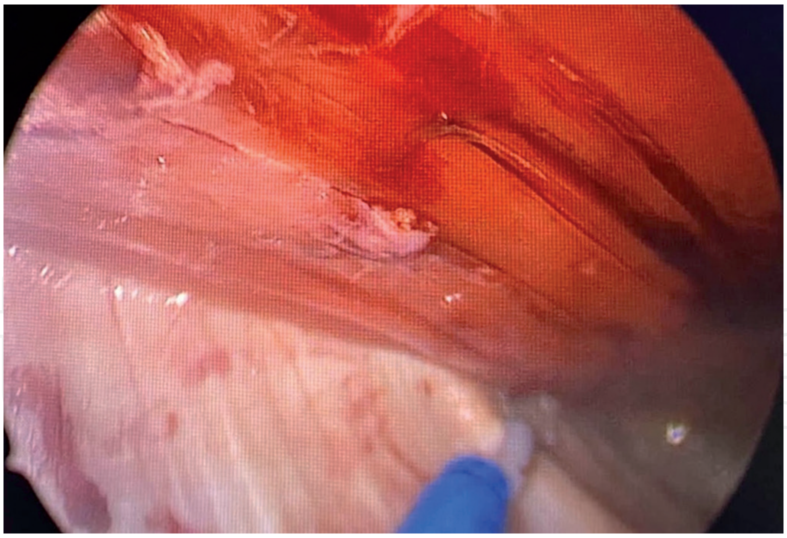

**Figure 3.**
*Division of medial aspect of anterior rectus sheath to access the linea alba and cross the midline to the right anterior rectus sheath.*

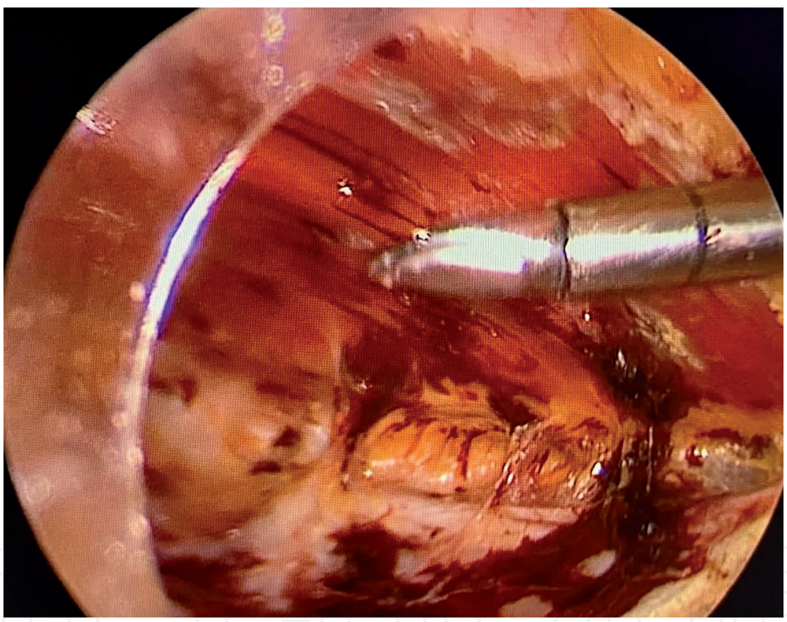

**Figure 4.**
*Robotic trocar placement.*

should be careful to avoid injuring neurovascular bundles penetrating the retromuscular plane. The lateral border of dissection is the semilunar line if not performing a concurrent TAR procedure.

The hernia sac is then reduced and, if necessary, opened carefully (**Figure 5**). One should avoid using electrosurgical energy during this portion of the procedure to avoid thermal injury to possible underlying bowel or other intraperitoneal structures. After reduction of contents, closure of the parietal peritoneum and the posterior sheath is performed with running barbed monofilament suture (**Figure 6**). The anterior aspect of the hernia fascial defect is then closed primarily and, if appropriate, the patient's rectus diastasis may be plicated at this time

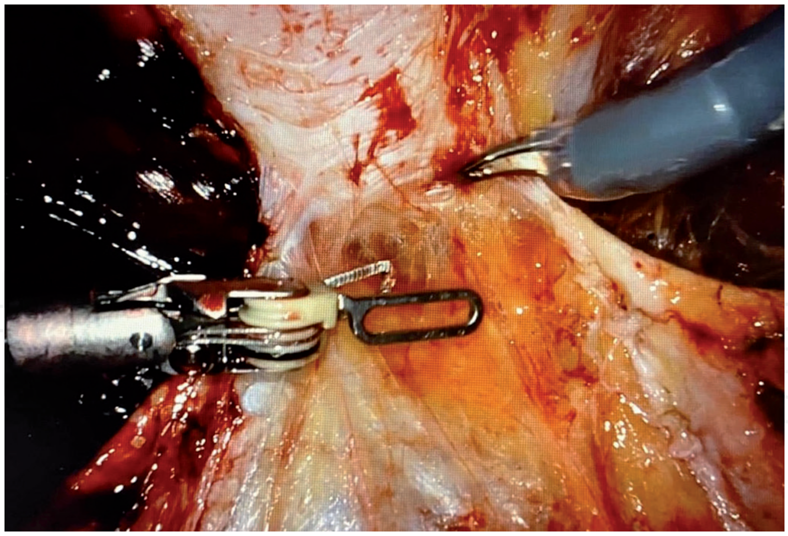

**Figure 5.**
*Reduction of the hernia sac and contents.*

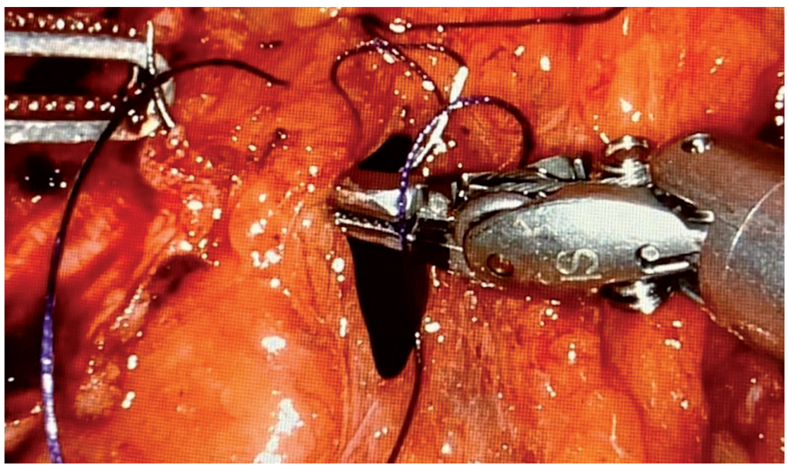

**Figure 6.**
*Primary closure of peritoneal defects and posterior sheath.*

using the same suture used to close the hernia defect or a separate one. This is an excellent opportunity to relieve the deformity caused by rectus diastasis and provide a plication and restoration of function to the abdominal wall with the hernia repair (**Figure 7**).

The cavity which has been dissected is measured to size the mesh appropriately. This may be accomplished by inserting a flexible ruler through a port and later retrieving it after measurement, or one can estimate the length using the 2.5 cm-long fenestrated bipolar grasper tip. Meticulous hemostasis is ensured before the insertion of mesh. If needed, hemostatic agents may be instilled into the cavity at this time. At our center, we prefer to use uncoated, nonabsorbable in this space if the procedure is performed in class 1 surgical wound, or uncoated biosynthetic hybrid mesh if the wound is class 2 or above with multiple risk factors such as obesity, type 2 diabetes, connective tissue disease, or advanced age with cardiovascular disease. The risk of contamination is minimized as the peritoneal space is not significantly violated except when reducing the hernia contents and the mesh is separated from the bowel by the transversalis and extraperitoneal fascia. Due to the presence of fascial layers deep in

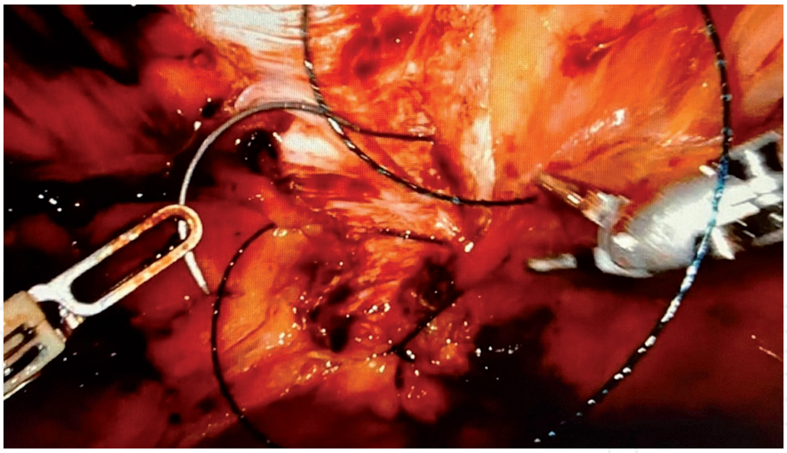

**Figure 7.**
*Anterior fascial defect closure +/− rectus diastasis plication.*

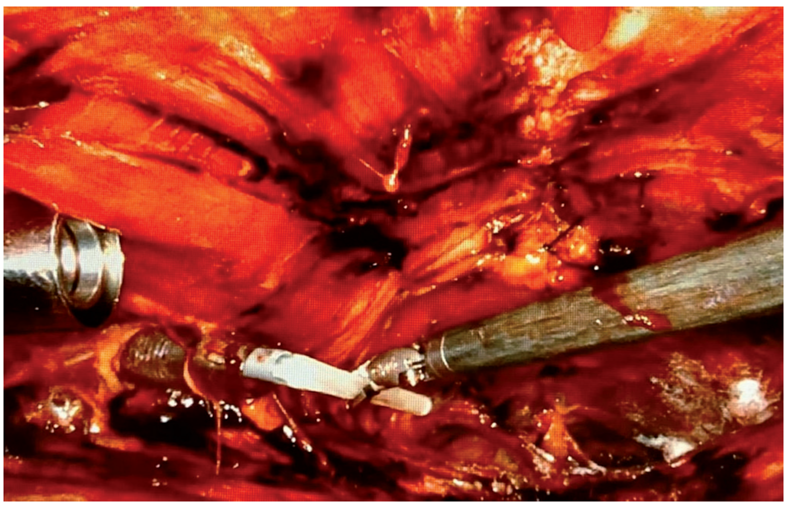

**Figure 8.**
*Mesh introduction and deployment +/− hemostatic agent.*

**Figure 9.**
*Drain placement.*

the retromuscular space, coating of the mesh is not necessary as it does not contact the bowel.

After selection, the mesh is rolled up and inserted through one of the trocars using an atraumatic grasper **(Figure 8)**. If the mesh is too large to be inserted through an 8 mm port, one of the ports may need to be upsized to a 12 mm port. The use of a hemostatic agent or powder is helpful to prevent seroma and hematoma formation.

Since concern for hematoma or seroma formation exists, a closed suction surgical drain is placed in the retromuscular space prior to desufflation and removal of trocars **(Figure 9)**. The drain typically only stays for a week or two, since keeping it for a longer period of time may also be a nidus for infection. Finally, the retromuscular space is desufflated under direct vision and incisions are closed using Monocryl suture in a subcuticular fashion.

## 5. Robotic transversus abdominis release (TAR)

Similar to eTEP, the TAR technique offers a retrorectus dissection, but from a transabdominal/intraperitoneal approach and with the additional advantage of extending itself lateral to the semilunar line to release the muscle and facilitate a posterior component separation. The patient is placed in a supine position. Arms are tucked loosely to allow them to drift slightly posteriorly. This allows for an additional range of motion for the robotic arm to prevent the patient's arm from colliding with it. This also ensures that the superior-most port does not collide with the patient's arm when placed out laterally. Care is taken not to hyperextend the shoulder during positioning. Due to this positioning, one can also perform a transversus abdominis release from either side of the patient without having to reposition them.

Optical entry in the left upper quadrant utilizing a 5 mm laparoscopic port. Once pneumoperitoneum is obtained, an 8 mm robotic trocar is placed in the left lower abdomen and another in the left lateral abdomen. The original 5 mm laparoscopic

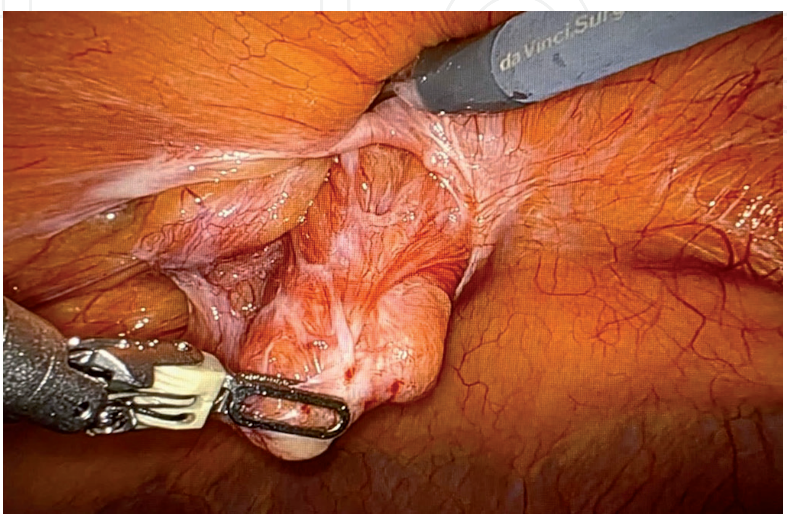

**Figure 10.**
*Reduction of hernia sac and contents with adhesiolysis.*

port is upsized for a 12 mm robotic trocar. The typical approach per our preference is from the left side of the abdominal wall to first develop the right retrorectus space from a transabdominal/intraperitoneal approach.

After general surveillance of the abdomen and robotic adhesiolysis if indicated, the hernia sac is reduced and the contralateral posterior rectus sheath is clearly identified **(Figure 10)**. Depending on the size and extent of the falciform ligament, it may have to be mobilized superiorly **(Figure 11)**.

Once the contralateral (right) posterior rectus sheath is clearly defined along the edge of the hernia defect, it is divided 0.5–1 cm medial from its edge to enter the plane where retrorectus dissection will take place. The contralateral retromuscular plane is developed laterally toward the linea semilunaris to the medial aspect of the lateral edge of the rectus abdominis, where the posterior sheath is divided in the upper abdomen just inferior to the ribcage to enter the proper plane and visualize the underlying

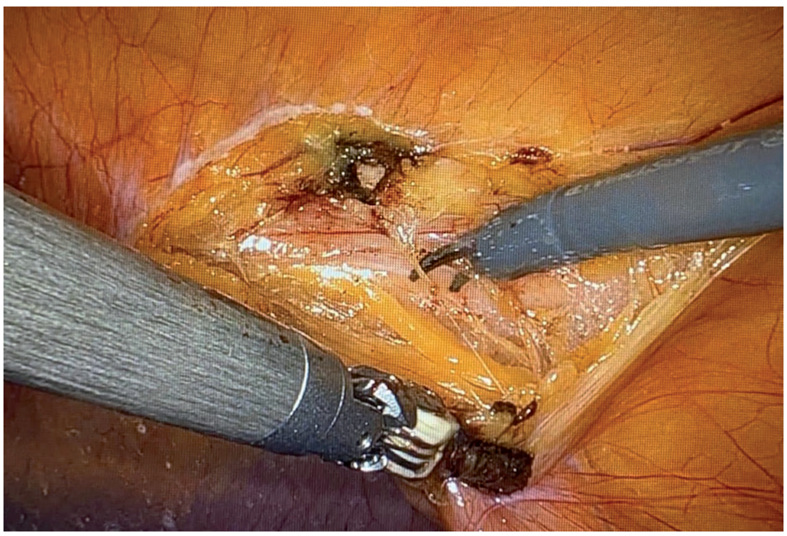

**Figure 11.**
*Superior mobilization of falciform ligament.*

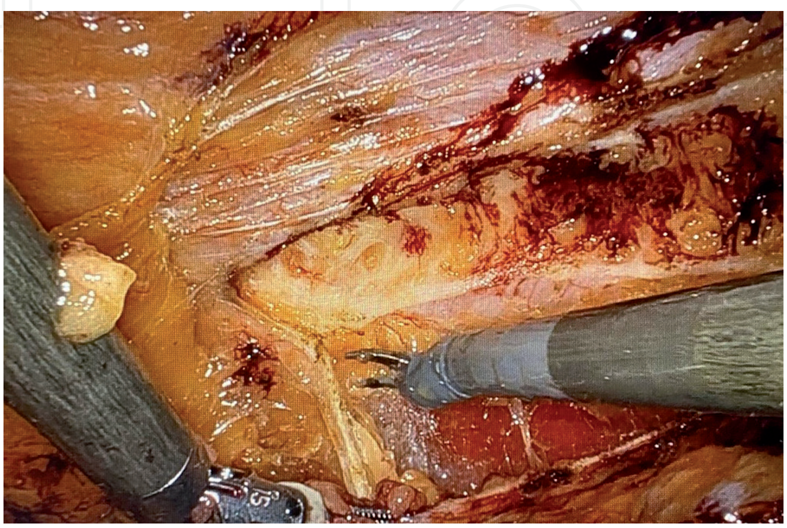

**Figure 12.**
*Right retrorectus flap creation with preservation of neurovascular bundles.*

transversus abdominis **(Figure 12)**. The neurovascular bundles that are penetrating the posterior sheath are preserved. The entire length of the transversus abdominis is then incised with electrosurgical energy at its medial edge. This allows entrance to the space above the transversalis fascia and is carried out 2 cm lateral to the linea semilunaris. This plane can be dissected to reach the space of Retzius anteriorly to the urinary bladder, and the subxiphoid space superiorly **(Figure 13)**.

Once a satisfactory retrorectus space is developed, mirror image steps are repeated on the opposite site **(Figure 14)** including the position of the ports **(Figure 15)**. There will be a total of three 8 mm robotic trocars placed on the right side of the abdomen.

The floor of the large retrorectus space is reconstructed after the bilateral TAR posterior component separation by closing the posterior sheath with a running barbed monofilament suture in a running fashion **(Figure 16)**. This step can be performed tension-free due to the component separation bilaterally.

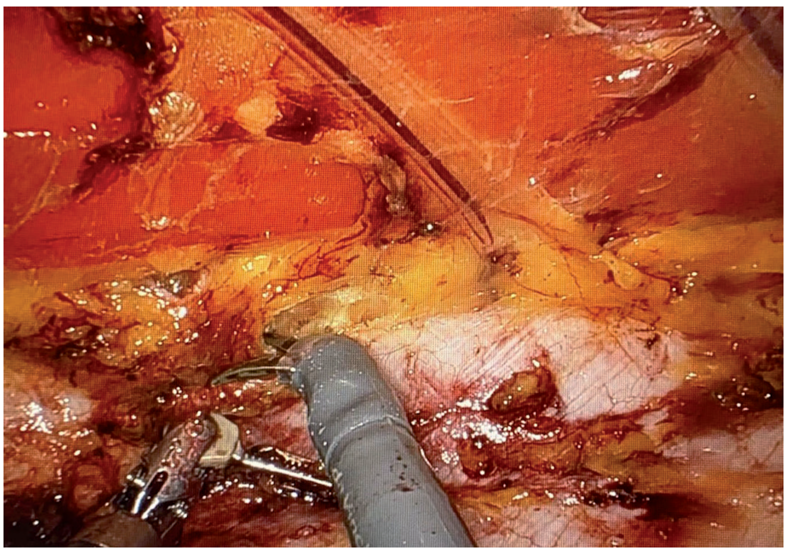

**Figure 13.**
*Right TAR at 2 cm lateral to semilunar line.*

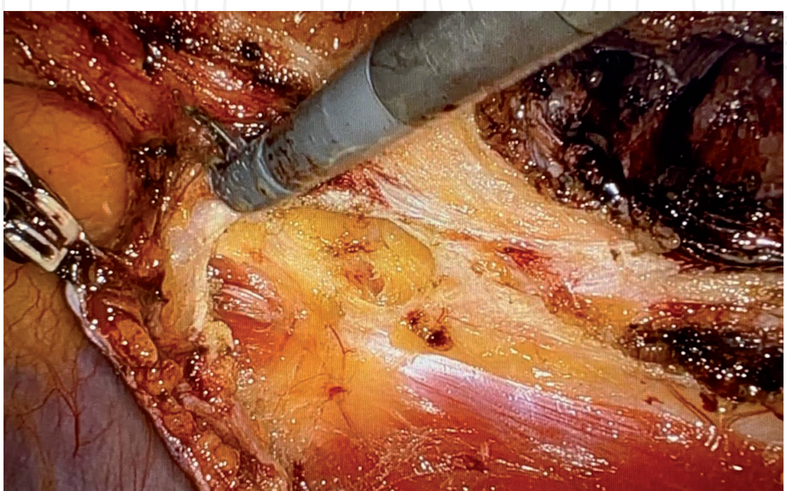

**Figure 14.**
*Left retrorectus flap creation with preservation of neurovascular bundles.*

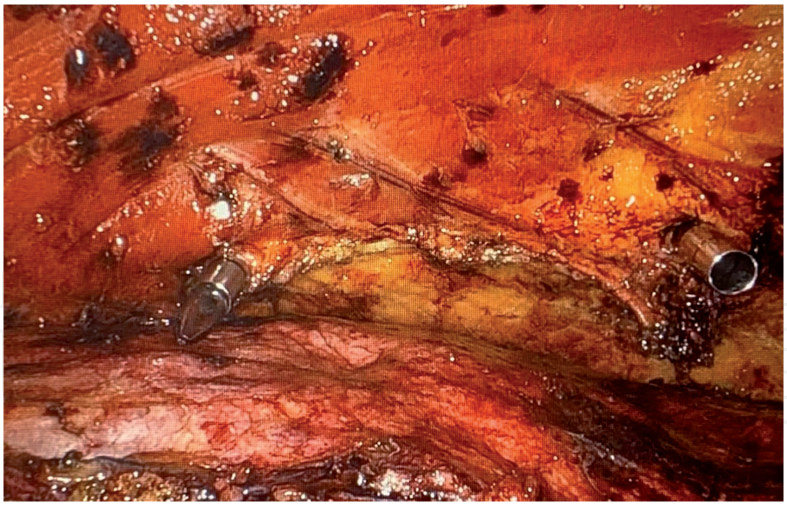

**Figure 15.**
*Right abdominal wall port insertion before flipping the boom.*

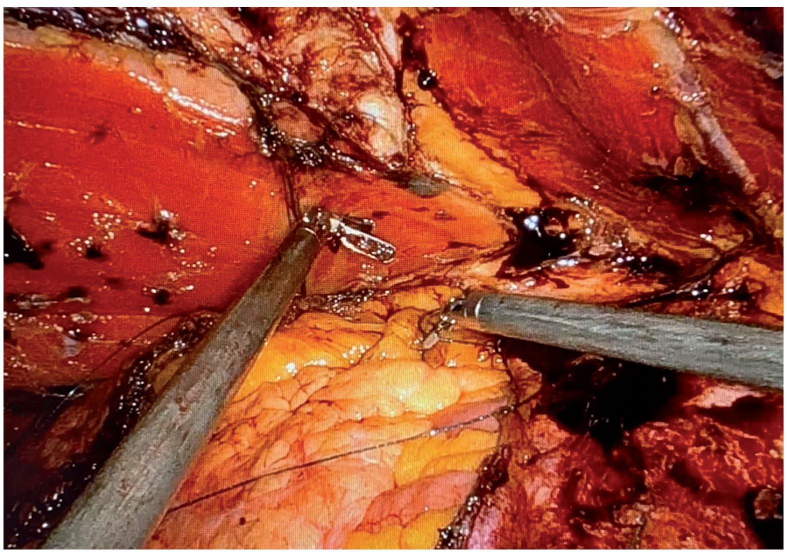

**Figure 16.**
*Posterior sheath/peritoneum closure.*

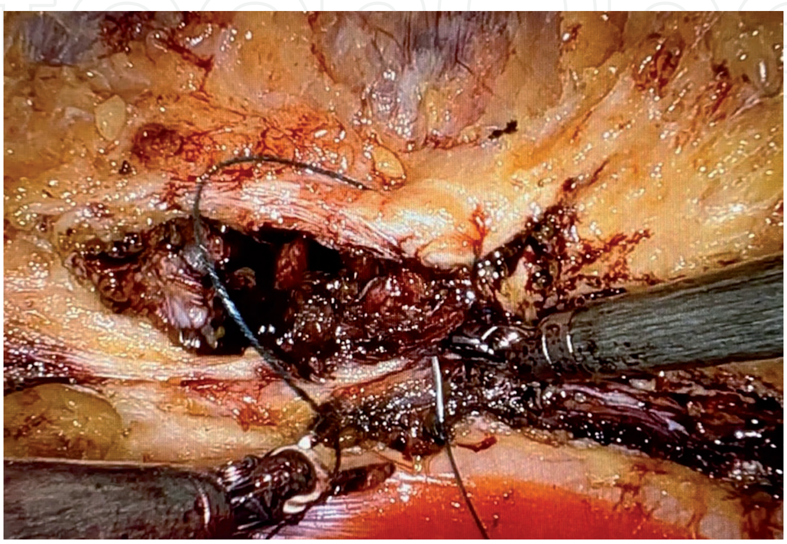

**Figure 17.**
*Anterior fascial closure +/− rectus diastasis plication.*

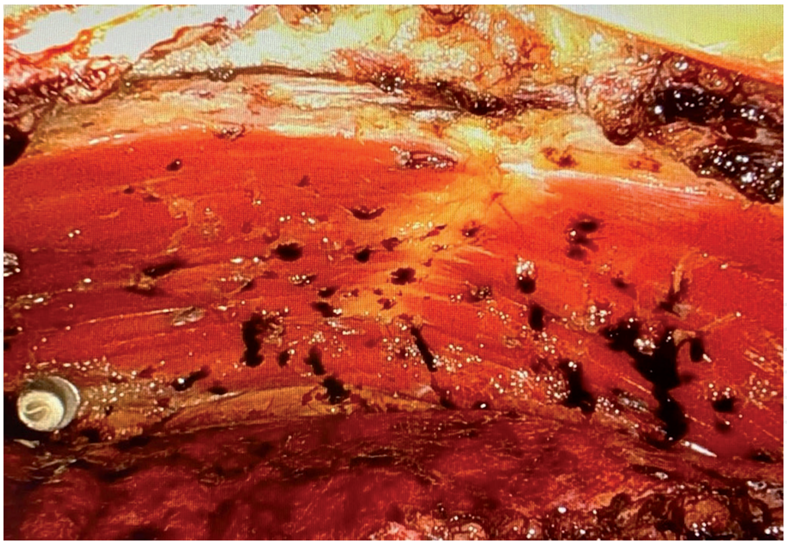

**Figure 18.**
*Mesh introduction +/− hemostatic agent.*

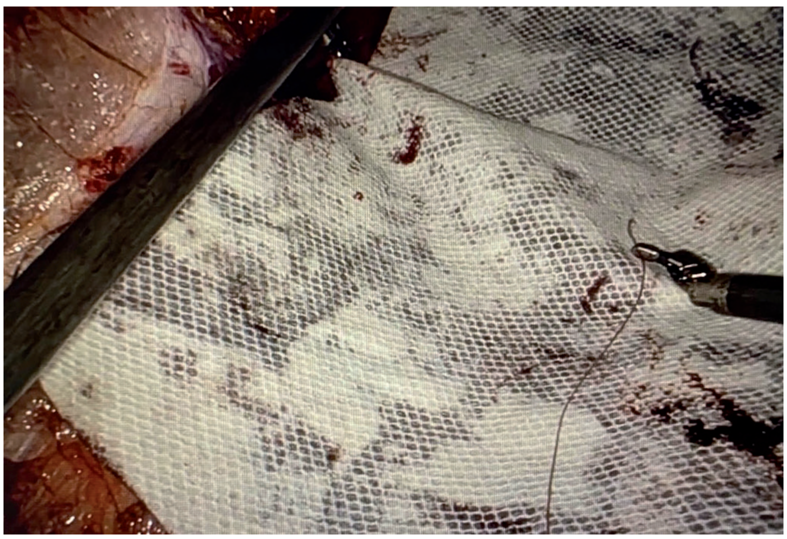

**Figure 19.**
*Mesh positioning in preperitoneal space.*



The next portion involves closure of the anterior fascial defect corresponding with the hernia and rectus diastasis plication (if present) with a running barbed monofilament suture (**Figure 17**).

A preperitoneal mesh is introduced via a 12 mm robotic port in the left upper quadrant (**Figure 18**) and it is deployed over the now-closed posterior rectus sheath (**Figure 19**). Above the mesh is the closed anterior fascial repair. There is no need to suture the mesh because it will remain in place between the muscle layers and fascial layers.

Hemostatic agent powder is placed over the mesh to promote adhesion of the mesh and reduce the incidence of seroma/hematoma. A total of two surgical drains are placed over the mesh to capture the extra fluid that would be produced in the newly formed space and prevent a seroma formation (**Figure 20**). The drains exit via the upper quadrant incisions and are secured to the skin with a suture.

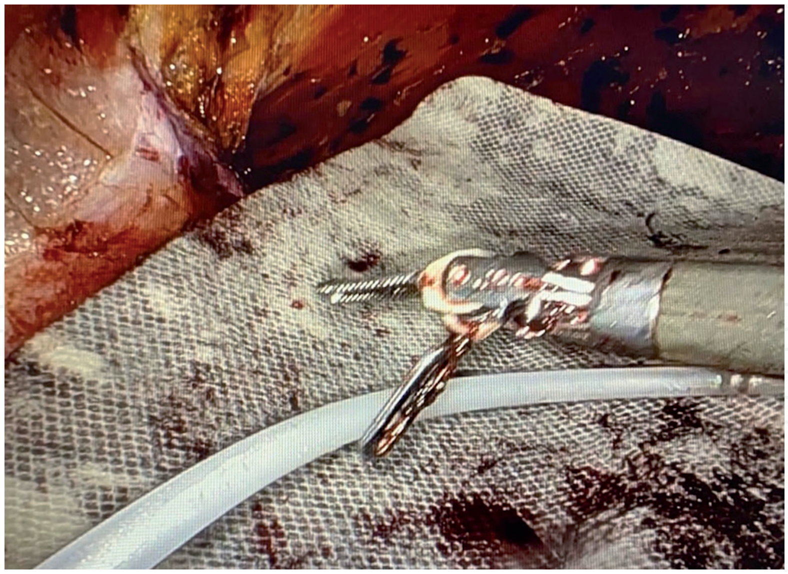

**Figure 20.**
*Bilateral drain insertion.*

## 6. Complications and management

Robotic ventral hernia repair is considered a safe and durable procedure. Indeed, open, endoscopic/laparoscopic, and robotic-assisted approaches are effective for ventral hernia repair with comparable overall outcomes. Nevertheless, each approach may demonstrate different advantages and disadvantages. Published data demonstrate that patients undergoing robotic ventral hernia repair have a significantly shorter hospital length of stay, lower conversion rate, and a lower rate of complications compared to the laparoscopic approach. Moreover, the robotic approach has a lower 30-day reoperation rate and a similar operative time in comparison to the open approach. On the other hand, the laparoscope approach has a shorter operative time and is less expensive than the robotic technique [18–21].

The abdominal wall reconstruction, like any surgical procedure, can be prone to complications. These could be related directly to the procedure, or they may be nonspecific regardless of the type of surgery. Pre-operative risk assessment and post-operative strategies could lead to a reduction in the complication rate and must be considered in every patient. In this context, the development of the robotic approach is due to its performance in high-risk cases. It is well suited for patients with risk factors such as morbid obesity and diabetes where microvascular disease and effects on the blood supply interfere with the healing of the abdominal wall. Moreover, patients with previous hernia repair by open surgery, connective tissue diseases, and rectus diastasis can take advantage of this new technique.

Despite the benefits and efficiency of the minimally invasive technique and the component separation procedure, several complications can pose postoperative challenges for the patient and surgical team [22–29]. Seroma and hematoma represent two of the most common postoperative complications after ventral hernia repair. However, since they have been described in the literature following different parameters, their real clinical incidence is variable. Seroma consists of an accumulation of clear fluid under the skin and usually develops where larger parts of tissue have been removed. It often has a minimal impact on the patient, but sometimes it could result in patient dissatisfaction, discomfort, poor esthetic outcome, and surgical site infections. Moreover, major seroma-related complications could lead to deep infection, mesh rejection, and hernia recurrence. Asymptomatic seroma can be managed conservatively, but esthetic complaints, complications, symptomatic, and chronic forms require medical treatment. The first-line treatment should be the drainage of the liquid, eventually followed by repeated aspirations and a microbiological examination if an infectious process is suspected. If this approach is not effective, it might need an operative intervention with drainage of the fluid and removal of the pseudo-capsule.

Among the most common complications, there are surgical site infections (SSIs), including superficial, deep, or mesh infections. Independent predictors of SSI could be steroid use, prolonged operative time, and smoking. SSI can represent a dangerous postoperative complication and is a significant risk factor for recurrence. Furthermore, soft tissue infection is a serious, life-threatening condition that could lead to necrosis of the skin, muscles, and soft tissues. Most superficial infections can be treated with antibiotics plus accurate and regular wound care. Chronic superficial and deep mesh infections require a surgical approach because antibiotics alone typically have a poor success rate considering the bacteria's biofilm around the mesh that protects them. Debridement and lavage of the wound delineate the first crucial step followed by explanation of the infected mesh material, even if this maneuver causes secondary trauma to the abdominal wall and might be associated with a higher risk of complications. Microbiological analysis of the fluid surrounding the mesh is necessary for post-operative specific antibiotic therapy.

Besides the infectious process, the mesh can trigger a non-infectious reaction characterized by inflammation, fibrosis, and calcification. This phenomenon called "foreign body reaction" consists of an autoimmune response to a foreign body, producing organized granulation tissue. Specifically, the pathophysiology is explained by the attraction and stimulation of macrophages, which release cytokines, growth factors, matrix-modulating factors, and complement activating factors. Depending on the mesh used, the chronic granulomas could be more extensive and create a thick collagenous scar adherent to the abdominal wall. Indeed, they are characterized by an increased cell turnover that continues for periods of several years after the implantation of the mesh. Usually, the clinical manifestations could be a rejection or migration of the mesh, characterized by chronic pain [30, 31].

During an abdominal wall reconstruction, some tissues may be injured. Especially superficial and deep nerve structures and muscle components are at greater risk. If cutaneous nerves are damaged during the incision, these can take a notably long time to heal, and they may never completely recover. This situation implies a total or partial loss of sensation in localized areas. Moreover, even if muscle atrophy is often a direct consequence of incisions, sutures, or reduced blood supply, it is also associated with denervation. For all these reasons, abdominal surgery could be linked to a dysfunctional abdominal wall musculature. While denervation is more difficult to treat, transected muscles such as external and internal oblique or transversus abdominis could be reconstructed primarily and repaired with mesh.

Intestinal disorders are part of the possible complications of complex abdominal wall reconstruction. Defective hernia mesh positioning, post-operative scar tissue, or adhesions can cause a mechanical blockage that generates bowel obstructions. These are clinically highlighted as colicky pain, constipation, nausea, and vomiting. Furthermore, as in all abdominal surgeries, there is a risk that the abdomen temporarily loses its usual rhythmic contraction. The loss of peristaltic capacity, defined as paralytic ileus, is, in any case, a temporary condition and lasts from a few hours to a few days. Rarely, bowel injury can also happen, but this is most often due to a direct injury during port insertion or handling of the bowel with instruments such as during adhesiolysis.

Chronic pain and hernia recurrence are the most common long-term complications. Chronic pain remains difficult to evaluate and is usually defined as pain persisting for more than 3 months after surgery. More precisely, its clinical manifestations are mainly represented as increased sensitivity to pain and pain secondary to normally non-painful tactile stimuli. Some risk factors are preoperative pain, female sex, smoke, and younger age. The pathophysiology of neuropathic pain is explained sometimes by a surgical injury to a major nerve or an inflammation of the nerve as an adverse effect of mesh implantation. The injured and inflammatory cells release cytokines, bradykinin, and prostaglandins that activate nociceptors. Chronic pain is considered one of the most important factors for satisfaction, and its management depends on the proper identification of the etiology. Moreover, the experience of pain is more than the detection of noxious stimuli, social environment, and psychosocial factors should be considered alongside in the management of the patient. Concerning neuropathic cutaneous pain, medical treatment as topical lidocaine or capsaicin can help to block the conduction of impulses along nerves, by minimizing the transmission of pain. Oral drugs such as anticonvulsants, tricyclic antidepressants, serotonin-norepinephrine reuptake inhibitors can be used, too [32–34].

Morbidly obese and diabetic patients, those suffering from cardiovascular disease, immunosuppressed patients due to a prior transplant or immunocompromised for other reasons, and patients who underwent a prior hernia repair in a contaminated environment have a high risk of recurrence. All of the typical post-operative complications such as wound infection, seroma, hematoma, and wound dehiscence are present in these groups with several risk factors. A minimally invasive approach, including robotics, becomes relevant and crucial to the success of abdominal wall reconstruction in these patients.

To treat the recurrence of a hernia, choosing the optimal surgical treatment is of paramount importance. The surgeon must take into consideration various factors such as the technique previously used, the number of interventions and relapses, and other patient factors, such as smoking. Robotic ventral hernia repair has shown a low recurrence rate at a mean of 21 months postoperatively. Furthermore, it represents an optimal option for the treatment of complex recurrences considering the benefits of the minimally invasive surgical approach as well as increased dexterity and three-dimensional visualization. Indeed, this precision approach is often required for a correct and integral abdominal wall reconstruction, restoring the displaced tissues to normal anatomy and dynamics with a meticulous component separation to release the tension on the muscles and fascia. The rebuilding and restoration of a functional abdominal wall with the reinforcement offered by a robotic complex repair such as eTEP or TAR offers a durable, lifelong reconstruction to the patient [35, 36].

## 7. Conclusion

The techniques and approaches described in this chapter have evolved over time as a result of contributions from a collective group of surgeons who built their legacy upon the lessons learned from their predecessors. A robotic complex abdominal wall reconstruction is a highly demanding and technically specialized type of operation, but it does not mean that it should only be reserved for a certain category of surgeons. We strongly believe that all surgeons should be able to master these techniques with proper training, supervision, mentoring, and dedication to excellence and attention to detail. The relationship between anatomy and physiology becomes clear and obvious when a robotic abdominal wall reconstruction is performed to restore the mechanics and functionality that once existed in the human body before the development of a hernia. To learn how to achieve this monumental task takes a lifetime of perseverance and discipline, but it all starts with the desire to acquire this knowledge. This chapter intends to encourage its readers to enter the realm of robotic abdominal wall reconstruction with the highest purpose in mind: the highest possible quality of life that we can offer to our patients.

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