# 14 Minimally Invasive Component Separation for the Repair of Large Abdominal Wall Defects

E. Barbosa and F. Ferreira

## Introduction

Complex abdominal wall reconstruction (AWR) poses many challenging problems to deal with in order to obtain the best short and long term results.

When treating massive hernias several questions need to be addressed in order to achieve the best possible outcome. Most often these patients are multioperated, with serious impairments on their lives, waiting for the operation that will give them back abdominal function, quality of life (many times there are other important coexisting problems such as chronic infections and bowel fistulas) and with reasonable cosmesis. The only way to achieve these goals in such complex patients is through profound knowledge of anatomy and physiology, attention to every detail, careful planning, and the domain of several techniques. The AWR surgeon must tailor the surgery to the patient instead of trying to include the patient into the technique.

According to the known forces of the abdominal wall [1] the best AWR is achieved when there is midline closure [2]. This is not always possible but still every attempt should be made to avoid as much bridging as possible. In large defects a simple midline closure is not achieved without tension unless some techniques are used such as component separation.

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Anterior component separation technique for the treatment of large abdominal defects was popularized by Ramirez et al. in 1990 [3], yet first described by Albanese in 1951 [4, 5]. However, subsequent literature reviewed the results of this technique pointing out some problems such as a relatively high recurrence rate and post-operative skin complications such as ischemia and frank necrosis [6]. Nevertheless the anterior component separation technique became appealing for the treatment of complex patients, specially in the contaminated setting where synthetic mesh is not recommended [7, 8] and in massive hernias with loss of domain [9], thus avoiding complex mutilating muscle flaps as an alternative reconstructive technique. To avoid the early problems described with open component separation, minimally invasive techniques appeared in the literature are the scope of the discussion for this chapter.

More recently, posterior component separation with transversus abdominal release (TAR), described by Novitsy in 2012 [10, 11] poses an important alternative to the anterior component separation and preferred by the authors in many of the AWR. Still this approach may not be suitable for every patient leaving an important role for anterior component separation either open or minimally invasive.

## Definition of Large Abdominal Defects

It is difficult to find in the literature a consensus terminology to classify the abdominal wall defects. Many terms like massive hernia, large abdominal defect, loss of domain, and complex abdominal hernia coexist and are not clearly defined. This presents a drawback when it comes to achieving a clear and common scientific language to compare results between procedures and centers. Some groups have proposed a classification systems for incisional ventral hernias in order to fill this gap and allow comparison of publications and standardization of terminology [12] but prospective studies are still needed to assess the clinical relevance of these classification studies and probably an individual


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classification for complex abdominal defects is required. Slater et al. recently classified incisional hernias according to complexity, proposing as a complex hernia the following criteria: size greater than 10 cm, presence of enterocutaneous fistulae, multiple previous operations, loss of domain greater than 20%, and presence of infected mesh [13]. Petro et al. also proposed a staging system that could correlate with morbidity and recurrence [14].

Size of the defect is a constant variable included in every system proposed and a cutoff of more than 10 cm in a transverse measure for the definition of large hernias is generally accepted. However, how accurately can one measure the abdominal wall defect in a consistent and reproducible manner is yet to be consensual. Pre-operative or intra-operative measures have some degree of surgeon bias and some authors defend a CT scan for more accurate and reproducible measures of the abdominal defect [15]. Also the method of area calculation should be always explained for accured comparison between studies as huge differences can be seen with different measuring methods. The authors usually measure the defects by CT and calculate the area of an ellipse.

Loss of domain can be tracked in the literature to the 1940s [16] but historically has no standard definition. It usually refers to a massive hernia with visceral contents outside its fascial boundaries in a manner that their return to the abdominal cavity cannot simply be made without a high chance of developing respiratory complications or even abdominal compartment syndrome. The relation between viscera outside/inside fascial boundaries is yet to be determined as a definition of loss of domain, specially because it is important to have in mind other aspects besides size, given that smaller defects may have important repercussion in ventilation considering the previous co-morbidities of the patient. Nevertheless, an extraperitoneal volume, measured by CT, of 20–25% is generally accepted [17, 18]. More accurately loss of domain is when the ratio of the volume of the hernia sac to the volume of the abdominal cavity is equal or greater than 0.5. In the presence of this type of massive hernias several pre-operative stages may be used as progressive pneumoperitoneum and chemical component separation with botulinum toxin in order to increase abdominal volume and abdominal wall compliance, to prevent dreadful post-operative complications such as pulmonary insufficiency and abdominal compartment syndrome.

In summary, size is not the only issue when considering the complexity of an abdominal wall defect and consequently choosing the best closing method. Other issues such as patient co-morbidities, the presence of an enterocutaneous fistula [19], and infected mesh or loss of domain pose additional important technical decisions.

## Surgical Options in Complex Abdominal Hernias

Although beyond the scope of this chapter it is important to briefly review the surgical options available for complex abdominal reconstruction, for a better understanding of the place for minimal invasive procedures.

Achieving the right timing for AWR is crucial. Controlling contamination, assuring the best control of patient co-morbidities and waiting enough time in order to avoid a hostile abdomen after a planned ventral hernia is a key for success. The presence of an enterocutaneous fistula take-down and simultaneously bowel continuity reconstruction with AWR has widely been proven to be safe [19, 20]. This is also the experience of the authors, leaving the two-stage approach only for heavily infected scenarios, such as in case of removal of an infected mesh, where the AWR is performed a few days after sepsis control.

Laparoscopic ventral hernia repair has established popularity for the correction of ventral hernias [21]. Although it has many advantages, the laparoscopic reconstruction technique involves intraperitoneal mesh bridging of the defect, which does not achieve a dynamic physiologic reconstruction [22]. However, with the association of a video-assisted component separation it is possible, in selected cases, to achieve midline closure. The combination of anterior component separation and laparoscopic hernia repair gives the patient the benefits of both techniques with high functional results and low recurrence rates [23–25] but literature data is still scarce. Unfortunately, in large and complex abdominal wall defects, laparoscopy may be technically challenging and therefore not feasible. Also in the presence of enterocutaneous fistulae, poor skin quality (skin graft, ulcers, and excessive pannus), loss of domain, and mesh infection or extrusion an open procedure imposes, although in selected cases a minimally invasive anterior component separation still may be applied as an adjuvant of the laparotomic approach.

For functional abdominal wall reconstruction the midline reapproximation is a key point. In some complex cases as with simultaneous enterocutaneous fistulas but not a very wide defect this can be achieved with a Rives-Stoppa–Wantz where the posterior rectus sheath is mobilized and closed and a mesh is placed in the retrorectus muscle space, with anterior sheath closure. Unfortunately, in large defects this technique is not enough for midline closure and either an anterior or posterior component separation with TAR may be necessary. There has been a shift towards posterior component separation with TAR in the last years which the authors also follow [26]. Nevertheless, which of the two techniques achieve the best cosmetic, functional and long term results is yet to be established in a definitive way and probably both have a place in the complex AWR.

## Anterior Component Separarion Technique

The concept of anterior component separation involves the release of the external oblique fascia from the anterior rectus sheath, starting 5–6 cm above the rib cage to the inguinal ligament, causing the midline slide of the muscle complex formed by the rectus—internal oblique—transversus abdominis (see Fig. 14.1). Extra mobilization can be achieved by release of the posterior rectus sheath (see Fig. 14.2).

The anterior component separation technique, besides the capability of closure for large abdominal defects without using prosthetic material, reconstructs a functional abdominal wall. This is impossible to achieve in the classical methods of mesh bridging without midline approximation.

Since the original technique of anterior component separation was described, many variations have been made, mostly to avoid the morbidity associated with extensive cutaneous flaps. Even in the open technique perforating vessels

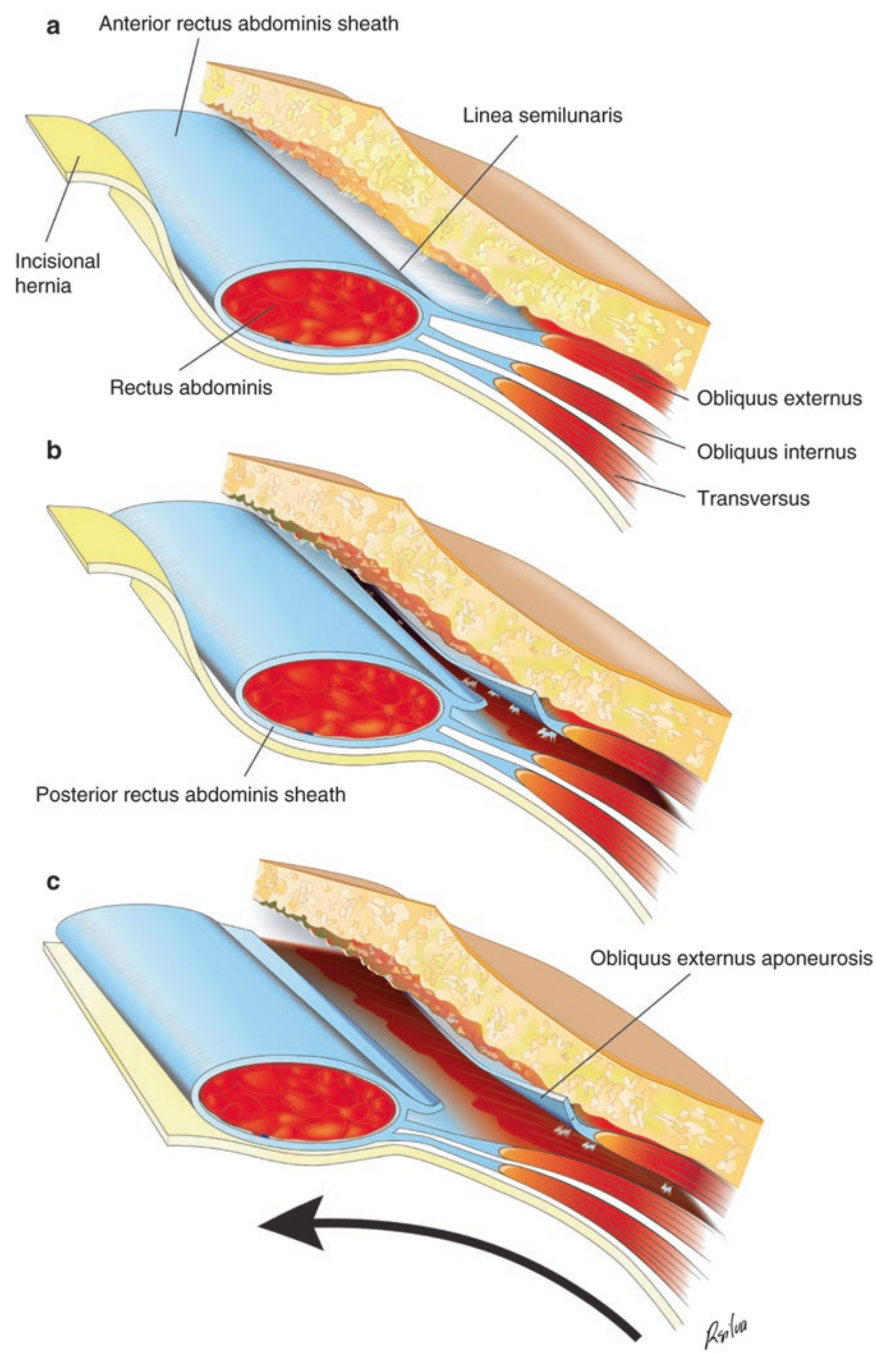


**Fig. 14.1** (**a**) Normal anatomy of the abdominal wall. (**b**) Section of the external oblique 1–2 cm lateral to the semilunaris line. (**c**) Dissection of the external oblique muscle from the internal oblique in order to allow the muscle complex formed by the rectus–internal oblique—transversus abdominis to slide towards the abdominal midline

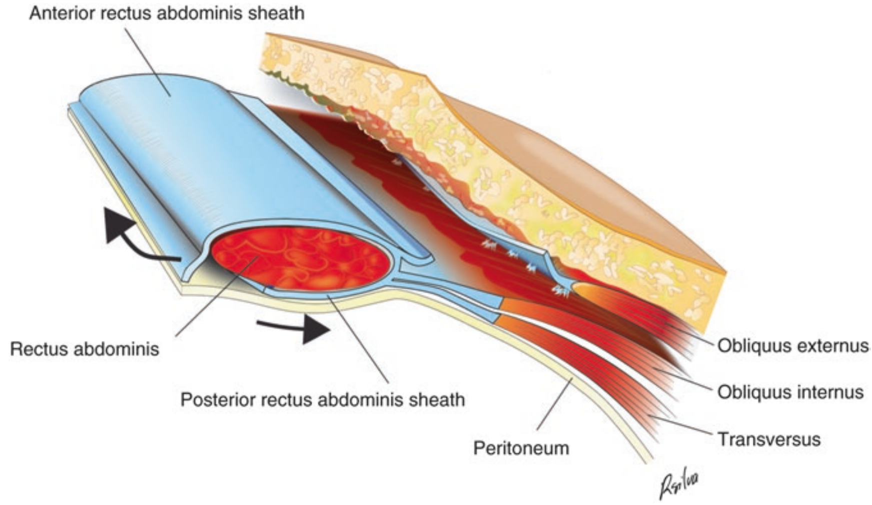


**Fig. 14.2** Section of the posterior rectus sheath to allow extra mobilization of the rectus complex

must be preserved in order to avoid skin ischemia, significantly lowering the morbidity of the procedure [27, 28].

Open anterior component separation is still an important armament for the abdominal wall surgeon in difficult cases, moreover for those defects that reach the lateral abdominal wall. Nevertheless the significant associated skin related morbidity, even with perforator preservator, must be taken into consideration.

## Minimally Invasive Anterior Component Separation Technique

### Introduction

When it comes to defining minimally invasive anterior component separation, a wide range of different techniques appears in the literature instead of a single well-defined approach. This concept can be divided into two large subgroups with a fundamental distinguishing characteristic: the use or not of video-assisted equipment to perform fascial dissection. In order to understand the different techniques under the same general name we have summarized the surgical approaches and descriptions based on these two subgroups.

### Minimally Invasive Component Separation Technique Without the Use of Video-Assisted Equipment

To avoid the large skin flaps and injury to perforating vessels, smaller incisions can achieve the same final goal on the release of the external oblique fascia. Dumanian et al. use a transverse subcostal incision to gain access to the external oblique fascia and perform the component separation under direct vision and their release takes about 15–20 min [15]. Buttler and Campbell also published their data on approaching the external oblique fascia through a tunnel created from the midline incision, avoiding two additional lateral incisions [29]. In this study, comparison to other methods is difficult, given that no description of operative times for the component separation alone, was reported.

It is necessary to have in mind that all these approaches are in fact less invasive, with lower complication rates than classical open techniques but they do not use video-assisted equipment and therefore need bigger incisions.

## Video-Assisted Anterior Component Separation Technique

Many different names are used under the same basic technical principles as endoscopic component separation, video-assisted component separation, and laparoscopic component separation. *Laparoscopy* derives from the Greek words *lapara*, which means "the soft parts of the body between the rib margins and hips" or "loin," and *skopeo*, which means "to see or view or examine" [30]. By analogy with laparotomy it generally implies the entrance in the abdominal cavity in order to examine or make a procedure inside the abdomen, which actually does not happen in the anterior component separation technique although the same surgical material is used. *Endoscopy* is derived from the Greek word *endon* "within" and *skopeo* "examine" [30]. Usually procedures take place through the endoscope itself with imaging guidance through imaging projection on a screen and actually some minimal invasive component separation are done by this method. Video-assisted surgery is a procedure that is aided by the use of a video camera that captures and projects the image on a screen. It is our opinion that despite the points of truth in every designation, the one that most accurately corresponds to anterior component separation is video-assisted (although it uses laparoscopic material) and will be described later in this chapter.

## Comparing Results from Different Anterior Component Separation Techniques

When comparing anterior component separation techniques there appears to be a general consensus regarding the beneficial effects of minimally invasive techniques compared to open anterior component separation, specially regarding post-operative pain and skin complications [31–35]. However, one of the main questions posed is if minimally invasive anterior component separation technique can offer the same rectus advancement as the open technique. Knowing that the release of the external oblique fascia alone does not promote complete advancement, it is mandatory to add the dissection of the external from the internal oblique muscle, moving the external oblique as laterally as possible, usually to the posterior axillary line. Rosen et al. have used a porcine model and demonstrated an average of 86% of the myofascial advancement with video-assisted component separation compared with a formal open release [36]. To our knowledge no similar comparative study exists between different minimally invasive techniques.

Regarding comparison of operative times, rectus complex advancement, complications, and costs between the different minimally invasive procedures studies are definitely needed. One of the problems pointed out in the video-assisted approaches are the costs and extra material involved when compared to the minimally invasive procedures without video-assistance. Rosen et al. reported that the total direct costs associated with video-assisted and open anterior component separation technique were actually similar because other issues are more important to global cost [37]. In fact, these patients usually represent extremes instead of daily realities and many other factors account for global cost and success such as the use of synthetic or biological meshes, post-operative complications, and hospital length of stay.

## Pre-operative Care

Treating massive and complex abdominal defects does not start on the day before surgery. It is usually a long curvy path until final reconstruction and many issues should be anticipated with meticulous surgical strategy. A detailed plan with alternative options should be used for successful closure in these challenging situations.

When using complex abdominal reconstructive techniques in the open abdomen it is important to make sure all the intra-abdominal problems are resolved. The use of CT or other appropriate imaging is helpful and adequate. In these critically ill patients it is very important to assure they are in the recovery phase of their illness, with fluid control for an optimized negative fluid balance, good nutritional status, and exclusion of any major infection. Although surgical aggression promotes another catabolic phase before the final recovery phase, the closure of the open abdomen ends a vicious cycle of pro-inflammation. With this in mind, the patient should be at his best physiological status before reconstructive surgery.

Nutritional status is essential for the post-operative recovery and should never be underestimated before any kind of major abdominal reconstruction. Special consideration should be addressed towards the high output intestinal fistula. The intestinal rehabilitation previous to surgery is often a challenging difficult step for the patient, the family, and the physician. Dealing with high output enterocutaneous fistulae is an extra burden for a physically and mentally exhausted patient. Even when no nutritional parameters are altered except for weight lost over 10%, their physiological reserve is at the limit. These individuals may not be able to recover well after surgery, increasing the probability of infection, anastomosis breakdown, poor wound healing, and should be managed in an experienced unit [38].

Determining the size of the defect is a critical step for meticulous detailed surgery preparation and future success. Our measurement is estimated in two ways: (a) transverse and longitudinal measurements when the patient is lying down in the supine position. These parameters allow the calculation of the area of the hernia equivalent to that of an ellipse; (b) measurement of the defect with a CT scan in every patient prior to surgery. It is our experience that CT measurement is usually smaller comparatively to directly measuring the patient either pre or intra-operatively. However, CT scan measurements are more objective limiting any surgeon bias [15]. Another important aspect of ordering a CT scan before every reconstruction is the evaluation of the abdominal wall muscles status given that true successful anterior component separation technique relies on the integrity of these muscles. Therefore CT imaging and 3D CT reconstructions may be helpful to fully access the complexity of the abdomen and properly plan surgery and are used by the authors in any major reconstruction [39] (see Fig. 14.3).

When dealing with planned ventral hernias with previous skin graft, it is best to allow enough time before reconstruction, usually 9–12 months [38, 40], in order to lower the risk of bowel injury during adhesiolysis (see Fig. 14.4). Closure of patient skin without any grafts can be approached earlier.

Assessing healthy skin status is essential for a good outcome and independent from the reconstruction of the abdominal wall. It is crucial to anticipate lack of skin coverage and adequate surgical technique either through skin expanders or flaps.

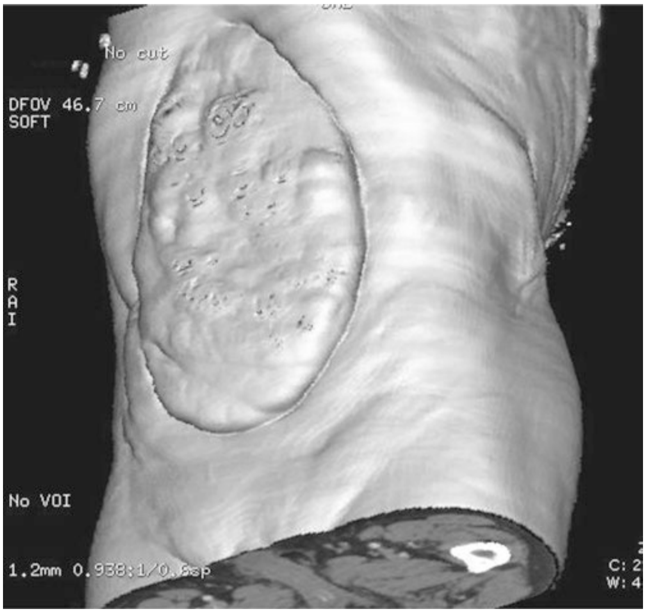


**Fig. 14.3** CT 3D reconstruction as a tool for pre-operative surgical technique programming

**Fig. 14.4** Skin pinch of the mature graft

Whenever possible, consideration must be taken to include the management of bowel and abdominal reconstruction in a single step or a two-step approach with bowel reconstruction before the definitive repair of the abdominal wall in order to avoid a contaminated procedure that may increase post-operative morbidity. This, however, has its risk, as patient will undergo two major operations. The authors experience, just as reported by others, that "one-stage" procedures are viable and, with the exception of superficial skin infections, do not increase morbidity [19, 20, 41].

Risk factors should be accessed and specially those known in the literature to predict post-operative complications like obesity, smoking, chronic pulmonary lung disease, immunosuppression, and diabetes [42]. The authors promote respiratory optimization/rehabilitation that prepares patients for a faster and uneventful post-op recovery.

Contamination also plays a role in pre-operative planning. Potential contamination may be expected with a previous wound infection, either superficial or deep, presence of a stoma or violation of the gastrointestinal tract. The presence or potential for contamination play a role in choosing the adequate mesh, at times in favor of a biologic, but there is still no consensus for the choice between a synthetic, biosynthetic, or biologic mesh [38, 43, 44].

During the anesthetic procedure it is extremely important to reduce intra-operative fluids to strictly the necessary amount. Goal-directed fluid policy has proven to be useful in reducing bowel edema and post-operative complications in a number of surgical areas [45]. We think this concept can also be safely applied when dealing with abdominal closure of massive defects. Good muscle relaxation is mandatory during the procedure in order to avoid excessive tension and technical difficulties. Thoracic epidural analgesia should be the standard of care as recent studies show a positive effect in lowering the intra-abdominal pressure. This type of specific analgesia leads to abdominal muscle relaxation lowering the risk of pulmonary associated complications. It is also associated with less post-operative complications in AWR [46].

Antibiotics are given 30 min prior to the beginning of surgery (except for vancomycin which is given 2 h before) and the choice depends on the type and degree of contamination of the wound and previous results of microbiologic cultures.

Finally, the surgery should be reviewed with the patient in order to discuss real patient expectations regarding cosmetic issues, because, eventhough almost always improved, they are definitely not the main goal of the surgery.

The success of this surgery requires on careful planning, attention to details of details and early involvement of other specialties as anesthesiology and the Intensive Care specialist when necessary in the whole process.

## Surgical Technique

Clear pre-operative landmarks are drawn on the abdominal wall. This allows everyone on the team to perceive the anatomic landmarks and major defects, facilitating understanding and communication (see Fig. 14.5).

### Step 1

Start with a 1–2 cm incision under the tip of the 11th rib, usually on the anterior axillary line. Continue dissection of the anatomical planes until the external oblique fascia is identified (see Fig. 14.6). Open the muscle fascia and make a blunt dissection of the underlying plane, between the external and internal oblique, in order to make Step 2 easier (see Fig. 14.7).


**Fig. 14.5** Abdominal wall anatomical landmarks and defect (Fig. 18.6 from previous edition)

**Fig. 14.8** Insertion of the trocar balloon for blunt dissection of the avascular plane between the external and internal oblique muscles

**Fig. 14.6** Opening of the external oblique muscle fascia through a 1–2 cm incision on the tip of the 11th rib

**Fig. 14.9** Connection of the $CO_2$ insufflator

**Fig. 14.7** Blunt dissection of the underlying plane of the external oblique, making insertion of the trocar balloon easier

### Step 2

Insert the trocar balloon (Spacemaker™ Plus Dissector System—Covidien, Dublin, Ireland) (see Fig. 14.8). After creating an avascular plane with blunt dissection between the muscles with the trocar balloon, connect it to the $CO_2$ insufflator aiming for an 8–12 mmHg pressure (see Fig. 14.9). Introduce a 10 mm 30° camera after removing the balloon (see Fig. 14.10).

### Step 3

Introduce a 5 mm trocar at the level of the posterior axillary line, in order to have a good dissection angle (see Fig. 14.10).

Make sure to identify the area above, the line of the fascia of the external oblique, 1 cm lateral to the semilunaris line, and cut the external oblique fascia all the way to the inguinal ligament (see illustrative Fig. 14.11). It is extremely important not to cut the semilunaris line or else a very complex defect will result.

## Step 4

Introduce another 10 mm trocar in the right iliac fossa in order to extend the component separation 5–6 cm above the costal margin. Here it is important to use a cautious haemostatic dissection, as the muscular fibers tend to bleed.

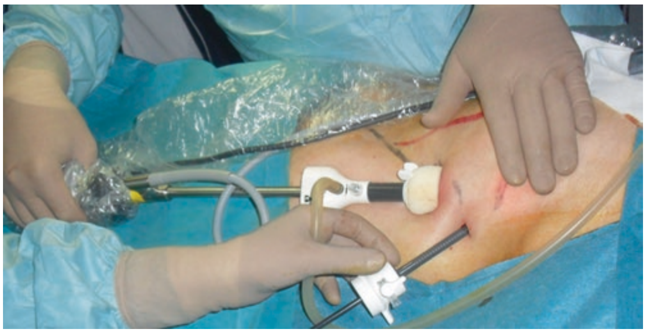

**Fig. 14.10** Insertion of a 10 mm 30° camera and introduction of a working 5 mm trocar in the posterior axillary line as it's a difficult working angle

## Step 5

It is important along the process to make sure the external oblique is well dissected from the internal oblique in order to achieve the best rectus advancement.

## Step 6

Sealed suction drains are placed through the most caudal trocar incision at the end of the surgery.

If a totally laparoscopic procedure is planned the surgery will proceed laparoscopic, midline closure is achieved in a shoelace manner, and a double layer mesh in an IPOM fashion is applied.

In massive defects laparoscopy is almost always technically challenging and not feasible. So, after video-assisted component separation the authors open the midline, and takedown any adhesions present which is many times a lengthy and meticulous job. Afterwards make the dissection of the posterior rectus sheath, close it with running suture long term absorbable monofilament 2/0 and preferably apply a retrorectus mesh and close anteriorly the linea alba.

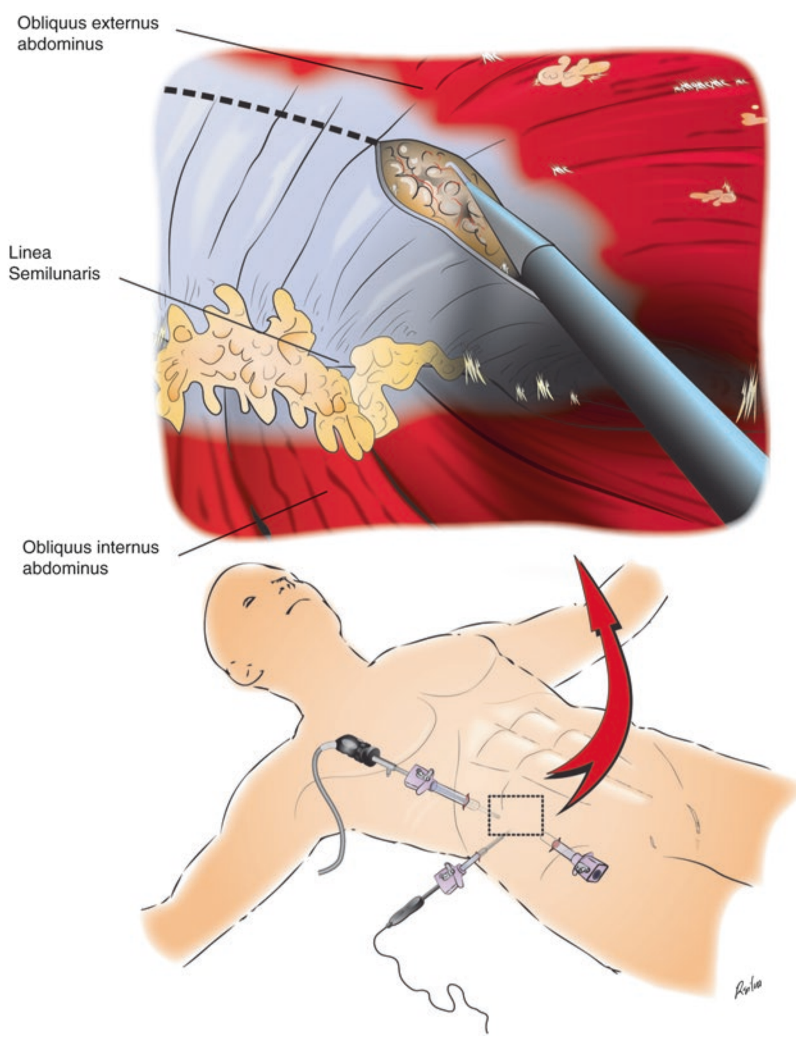


**Fig. 14.11** Trocar placement view and image projected on the screen. Section of the external oblique fascia lateral to the semilunaris line

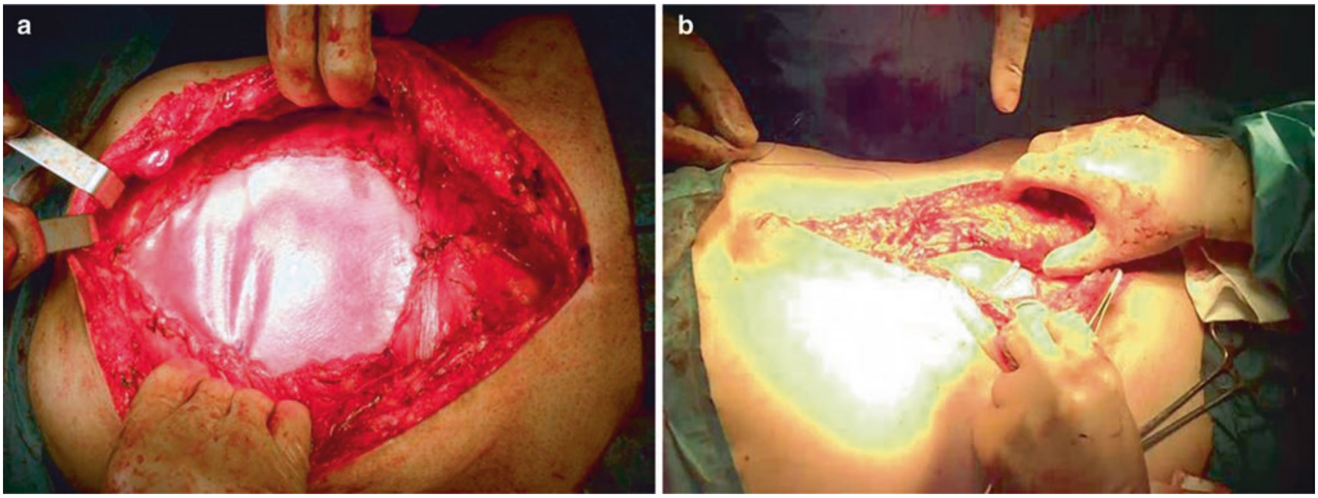


**Fig. 14.12** (**a**) Dissection of the posterior rectus sheath. As it was impossible to close the sheath in the midline, a biological mesh was placed intraperitoneally and fixed with transabdominal sutures. Inferior partial closure of the posterior sheath was performed, with a running suture over the mesh. (**b**) Anterior rectus sheath closure with a running suture over a closed-suction drain

Sometimes it is not possible to totally close the posterior sheath but its mobilization allows us an extra few cm to achieve the necessary mobilization of the muscle complex formed by the rectus-internal oblique-transversus to slide over the midline and achieve closure (see Fig. 14.12a, b). When midline closure is not feasible then an IPOM procedure is made, with transfascial mesh fixation in the cardinal points and closure of fascia over mesh in order to diminish the bridging defect as much as possible. This can be challenging to achieve after a video-assisted component separation that lack the large skin flaps of open procedures. We use a "clock," transabdominal technique, to secure the mesh with 12 corresponding "hour" sutures. The sutures are secured to the mesh and then passed through the abdominal wall with a suture passer. Some authors find it useful to introduce the laparoscope intra-abdominally at the end of the surgery and secure the rest of the mesh with tackers [47]. This may diminish the risk of bowel entrapment and difficulty in mesh incorporation which leads to increasing associated complications but it is not technically feasible for biologic meshes.

Either way, for proper abdominal wall reconstruction it is extremely important to have wide mesh overlap of the abdominal defect under correct physiological tension. Floppy mesh will increase complications as seromas, poor mesh integration, and in bridged defects, specially with biological meshes, a budging will be seen.

The skin is usually closed with staples and incisional negative pressure wound therapy is used for all the major AWR surgeries. Still there is no established evidence that this procedure reduces wound complications but there are some literature pointing that way [48, 49].

## Post-operative Care

As previously explained, effective analgesia, ideally with a thoracic epidural catheter, is extremely important for a good outcome. This aids in avoiding intra-abdominal hypertension (IAH) and also helps to prevent respiratory complications, specially in patients with chronic obstructive pulmonary disease (COPD).

After correction of massive hernias with loss of domain there is always a concern that the return of abdominal contents to its cavity may induce diaphragmatic compression and raise the intra-abdominal pressure, leading to an eventual abdominal compartment syndrome. Agnew et al. published data from abdominal volumetric studies that proved the existence of significant increased volume after anterior component separation, providing less pulmonary restriction and consequent complications [50]. Care is taken to administer to high risk pulmonary patients respiratory kinesiotherapy in the early post-operative period and in many cases, pre-operatively.

Unless patients are admitted to the intensive care unit (ICU) they sit up 6–12 h after surgery. Walking, as early as post-operative day 1, is incentivated.

Drains are usually left in place until less than 30 mL a day output is achieved.

Most of the patients submitted to minimally invasive anterior component separation, although going through a major abdominal wall reconstruction, recover faster and with less morbidity than those with an open technique. Most of the differences between the two groups are due to greater skin complications and post-operative pain in the open group. Usually patients are discharged around the sixth or seventh post-operative day physically active and doing situps. Longer hospital stays are usually related to previous co-morbidities instead of the procedure itself. Heavy physical activity is usually postponed until 6–8 weeks after surgery but the cutoff depends on individual characteristics and type of surgery.

## Special Cases

### The Open Abdomen

A vast majority of open abdomens are primarily closed without planned ventral hernias. Yet, in some cases this is simply impossible, specially in severe abdominal trauma or in a non-trauma setting with abdominal catastrophes. When closure cannot be achieved easily by suturing fascia, some techniques may be used to gradually assist in the closure of the abdomen with associated negative pressure wound closure. Negative pressure wound therapy with mesh mediated fascial closure is the preferred method of the authors [51–53]. Even with these procedures there are some cases where ventral hernia repair must be avoided and these techniques cannot be applied or were used without achieving the goal of primary abdominal closure. In this setting component separation technique can be used to achieve primary closure, usually with biological mesh reinforcement.

In order to achieve maximum results from this technique it is extremely important that the open abdomen be a Grade I or II [54]. This represents an abdominal wall without adhesions to the underlying bowel. Only in this manner can a complete abdominal rectus complex advancement be achieved (see Figs. 14.13, 14.14, and 14.15). If the patient has a temporary stoma and an open abdomen, it is best to save component separation for the definitive surgery.

Even in difficult cases such as cirrhosis with ascites, minimally invasive component separation technique can achieve abdominal physiological closure with low morbidity (see Figs. 14.16 and 14.17a, b), but mostly depends on institutional expertise.

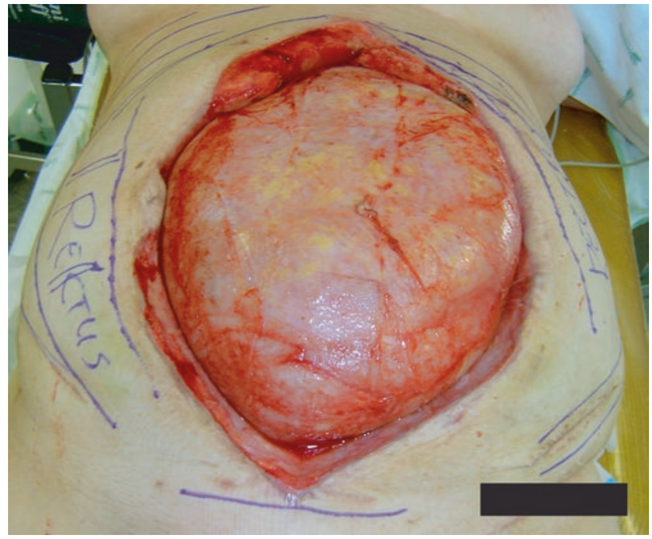


**Fig. 14.13** Open abdomen Grade IIa with a massive defect after post-operative shock due to a large spontaneous retroperitoneal hematoma. Previously treated with ABTheraTM–(KCI, San Antonio, TX)

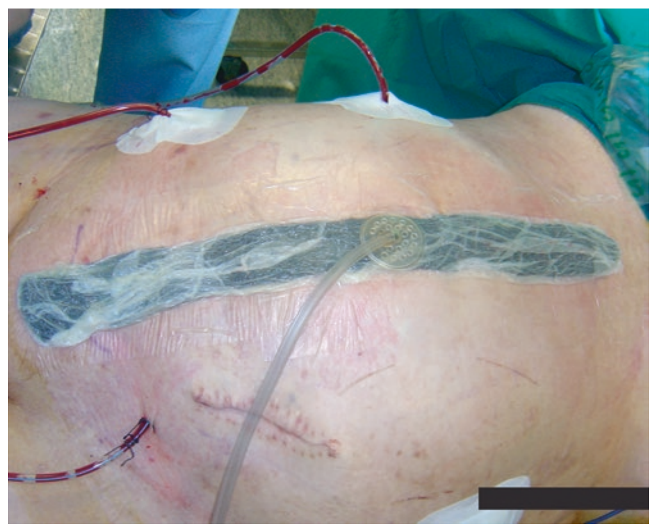

**Fig. 14.14** Abdominal reconstruction with minimally invasive component separation on the right and open component separation technique with perforating vessel preservation on the left due to a previous stomal hernia repair with synthetic mesh that was removed during the laparostomy. Underlay biological mesh with some degree of bridging was necessary to achieve reconstruction. Skin closure with staples and negative pressure wound therapy (V.A.C.® GranuFoam™ with silver gaze interface) applied to the wound due to high risk of infection

### The Use of Chemical Component Sepration and Tissue Expanders

Some patients with massive abdominal wall defects are expected to have significant abdominal wall retraction and fibrosis minimizing the advancement of the rectus muscle during component separation. In these cases tissue expanders prior to surgery could aid in obtaining a successful reconstruction [55, 56]. In order to achieve major rectus advancement, tissue expanders were placed between the internal and external oblique muscles and are gradually filled up to 4 months. This will create a foreign body response and a thick fibrotic capsule. When video-assisted component separation is performed the anatomical landmarks are distorted, and minimally invasive procedure is difficult and not feasible. Currently the authors no longer use tissue expanders between muscles and when there is a need for “loosening” of the abdominal wall muscles we prefer a chemical component separation.


**Fig. 14.15** (**a**) Two months after surgery, fully recovered with a functional abdominal wall even during abdominal contraction while standing up from the supine position. (**b**, **c**) 4 years after AWR. Needed a second intervention 3 years after the AWR to do a rectus plicature due to some bulging

When tissue expanders are subcutaneously inserted due to lack of skin, the video-assisted component separation is not compromised and may be performed in a standard manner (see Figs. 14.18 and 14.19).

## Stomas

There are few reports in the literature reporting the use of minimally invasive anterior component separation technique and stomas. Rosen et al. described the use of myofascial advancement flap combined with other techniques for the simultaneous repair of large midline incisional and parastomal hernias, with good results [57]. In our experience a preoperative CT assessment determining the position of the stoma is critical for decision-making. A trans-rectus and not a para-rectus stoma must exist to proceed for a video-assisted anterior component separation technique, otherwise bowel injury and complex defects may result. When relocation of the stoma is best warranted, the procedure must start with a minimally invasive procedure on the future side of the stoma. After re-location of the stoma a safer component separation

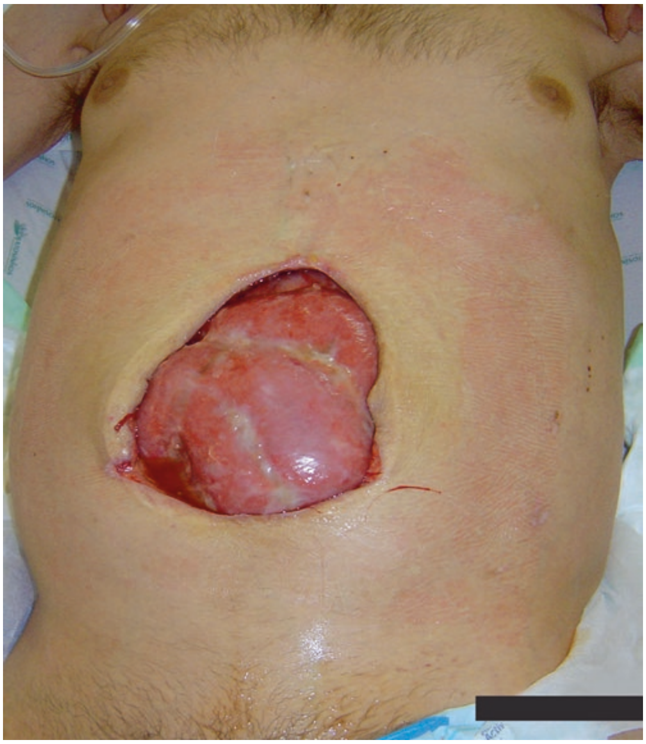

**Fig. 14.16** A cirrhotic patient with multiple eviscerations and infected ascites after a strangulated umbilical hernia and small bowel resection. Child-Pugh B score

can also be performed on ipsilateral side with adequate mesh reinforcement.

## Previous Anterior Component Separation

Repeating an anterior component separation is feasible but poorly described in the literature. The main issues are the real value of successful recurrent hernia repair adding a new anterior component separation and the possibility of achieving it by another minimally invasive procedure since fibrosis is expected. It appears that for these complex cases the best solution may be in fact a posterior component separation with TAR [58].

## Summary

Minimally invasive anterior component separation technique is a feasible and reproducible technique. This procedure allows, in some large defects, the restoration of the abdominal midline, helping to promote a more physiological abdominal reconstruction. If complete midline restoration is not possible, component separation helps in reducing the abdominal wall defect, decreasing the amount of mesh material necessary for a bridge repair, respecting as much as possible the physiology and movement of the abdominal wall.

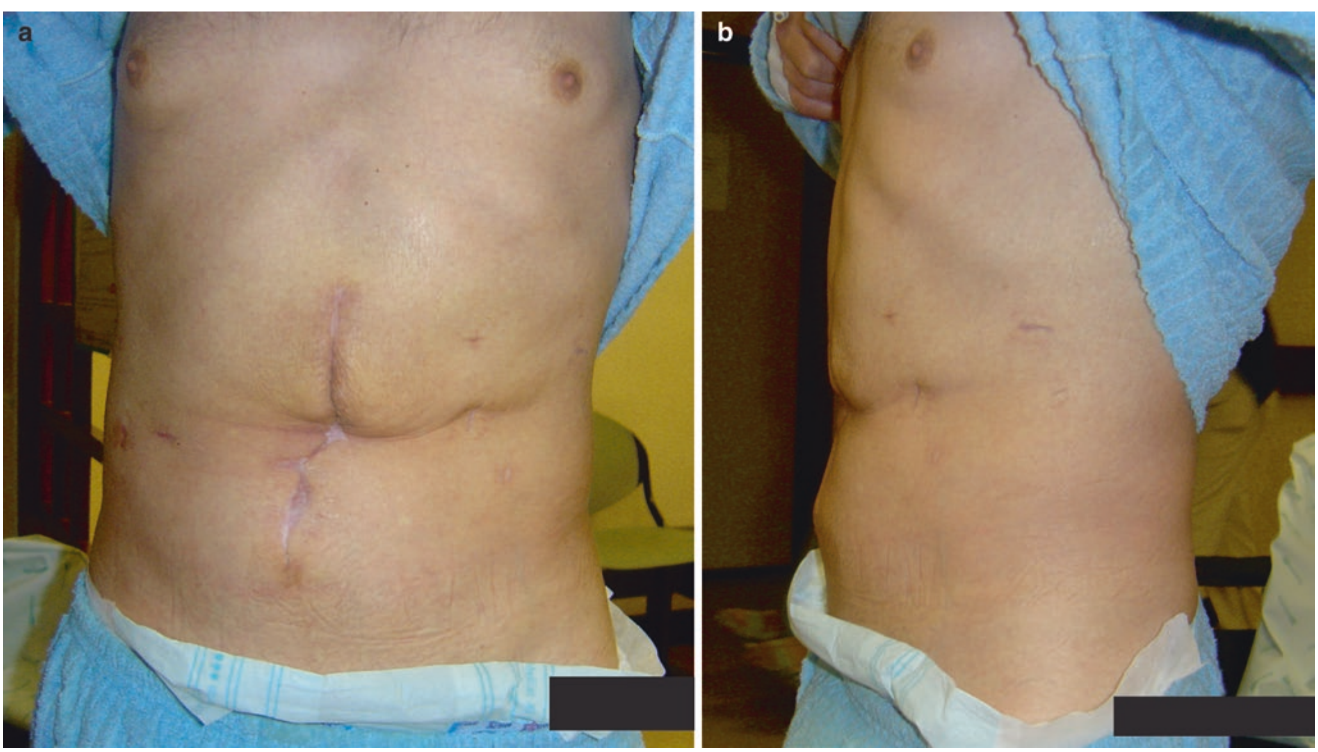


**Fig. 14.17** (**a**, **b**) Seven weeks post-operatively after video-assisted component separation technique achieving midline closure and reinforcement with biological mesh

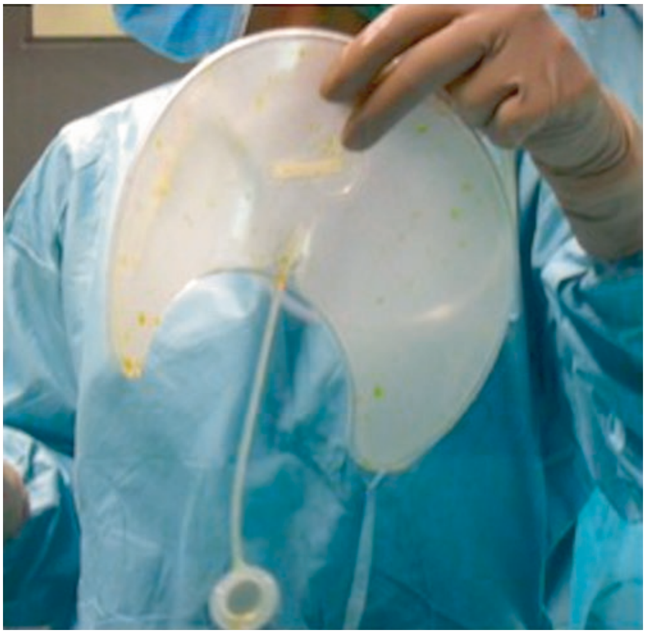

**Fig. 14.18** Tissue expander used nowadays only for cases when there is lack of skin

**Fig. 14.19** Complex ventral hernia with subcutaneous tissue expanders

Minimally invasive anterior component separation technique has many advantages over open identical techniques avoiding large skin flaps and consequent wound healing related problems. More studies are still needed to compare different minimally invasive techniques regarding advancement myofascial flaps and costs are also needed.

Finally, it is important to keep in mind that a minimally invasive anterior component separation technique is just a helpful part of a puzzle in the treatment of large and complex abdominal defects. Proper planning and attention to details are important for successful achievement and the abdominal wall surgeon must master several techniques in order to give the best possible result for a specific defect in a unique patient.

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