60 Component Separation: Options and Techniques

Ivy N. Haskins and Michael J. Rosen

60.1 Introduction

The management of large abdominal wall defects remains a clinical challenge for both general and plastic surgeons. In order to be effective, abdominal wall reconstruction must achieve four goals, including (1) prevention of visceral eventration, (2) dynamic and functional muscle support, (3) adequate soft tissue coverage, and (4) tension-free repair [1]. Prior to the original component separation technique described by Ramirez in 1990, the closure of large abdominal wall defects relied on the transfer of myocutaneous flaps, free tissue transfer, or a bridged repair with mesh [2]. Myocutaneous flaps and free tissue transfer adequately achieve the four goals of abdominal wall reconstruction but at the expense of additional morbidity at the tissue donor site, prolonged hospital lengths of stay, and ventral hernia recurrence rates as high as 40% [1, 3–5]. Routine bridging hernia repair is unable to achieve the four goals of abdominal wall reconstruction as it cannot reproduce the dynamic and functional support provided by the abdominal wall musculature and it, too, is associated with high recurrence rates [1, 6].

In response to these observations, Ramirez proposed the component separation technique as a means to facilitate complex abdominal wall reconstruction with the use of autologous abdominal wall tissue [2]. Since the original description of the component separation technique, several modifications have been proposed to this technique. Herein, we will detail the key steps, advantages, and disadvantages of the anterior component separation technique, the periumbilical perforator-sparing component separation technique, the laparoscopic component separation technique, and the posterior component separation technique.

I. N. Haskins, M.D. · M. J. Rosen, M.D., F.A.C.S. (✉)
Comprehensive Hernia Center, Digestive Disease and Surgery Institute, Cleveland Clinic Foundation, Cleveland, OH, USA

60.2 Anterior Component Separation Technique

60.2.1 Key Steps to the Procedure

1. The procedure begins with midline entrance into the abdominal wall cavity with lysis of adhesions performed, as needed.
2. Elevation of the skin and subcutaneous tissue off of the abdominal wall musculature is performed. This proceeds from a medial to lateral direction on both sides of the abdominal wall and should extend to the anterior axillary line.
3. The linea semilunaris is identified by manually palpating the lateral edge of the rectus muscle belly. A vertical incision is made approximately 2 centimeters (cm) lateral to the linea semilunaris into the external oblique aponeuro-

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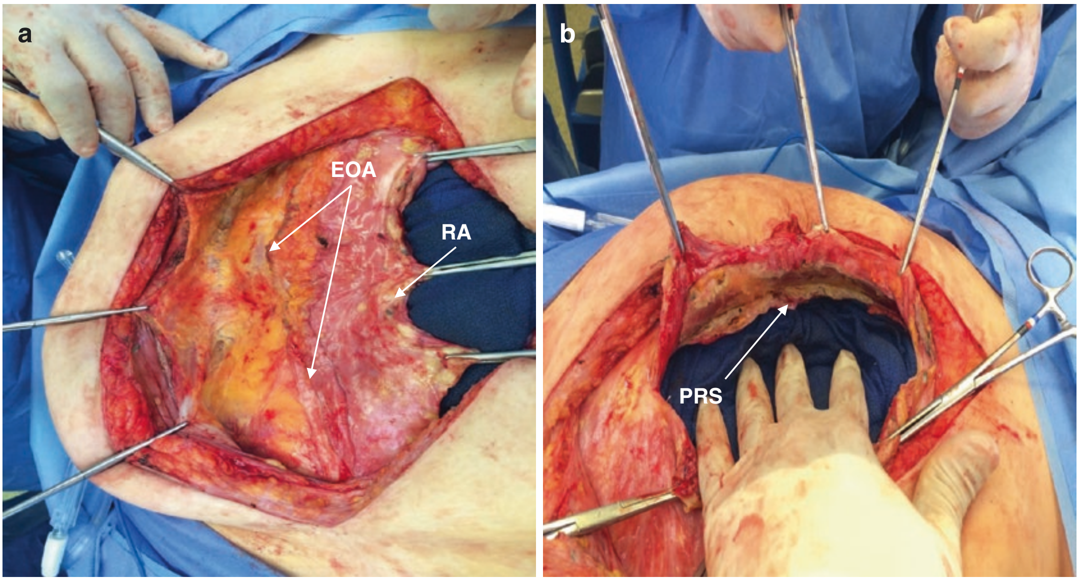

Fig. 60.1 Anterior components separation technique. (**a**) The external oblique aponeurosis (EOA) is incised from the costal margin to the inguinal ligament, allowing for medial movement of the rectus abdominis (RA) muscle for closure of the hernia defect. (**b**) Demonstration of posterior rectus sheath (PRS) incision that can be performed if the hernia defect cannot be closed with incision of the EOA only

sis. Care should be taken at this point to identify and preserve the internal oblique muscle. This incision is advanced from the costal margin to the inguinal ligament (Fig. 60.1a).

4. The avascular plane between the external and internal oblique muscles is developed using blunt dissection, with extension to the anterior axillary line.
5. If additional mobilization is needed, the posterior rectus sheath should be incised approximately 0.5 cm from its edge, with dissection of the rectus muscle off of the posterior rectus sheath (Fig. 60.1b).
6. At this point, the ability to close the abdominal wall is tested. To do this, Kocher clamps are applied to the anterior rectus fascia on either side of the abdominal wall and pulled toward the midline. The anterior component separation technique, with separation of the external oblique from the internal oblique and separation of the posterior rectus sheath from the rectus abdominis muscle, should allow for closure of defects up to 20 cm wide at the umbilicus in patients with a compliant abdomen [2].
7. The decision for mesh reinforcement and the location of mesh placement is determined. The options for mesh placement include intraperitoneally, in the retrorectus space, or as an onlay. For retrorectus mesh placement, additional mobilization of the posterior rectus sheath is often required. Once the pocket for the mesh has been developed, the posterior rectus sheath should be closed using a running, absorbable suture and the mesh placed into the retrorectus space above the posterior rectus sheath but below the rectus abdominis muscle. The mesh is then secured using multiple interrupted transfascial absorbable sutures. For intraperitoneal mesh placement, one should keep in mind that the mesh should be secured laterally on the abdominal wall in order to prevent wrinkling of the mesh when the midline is brought back together. Furthermore, since this mesh is in contact with the abdominal viscera, one should use either a protected synthetic mesh, a bioabsorbable mesh, or a biologic graft depending on the hernia type and wound classification. For onlay mesh placement, the

linea alba is re-approximated first with a running, slowly absorbable suture after which the mesh is placed on top of the anterior rectus sheath. When mesh is used for reinforcement of the hernia repair, irrespective of the location, one should ensure adequate coverage of the linea alba (at least 5 cm on either side) to reduce the risk of hernia recurrence [7, 8]. Furthermore, some surgeons advocate reinforcing the external oblique releases which may require placement of a larger mesh.

8. Placement of closed suction drains for management of postoperative seroma/dead space in the setting of mobilization of large lipocutaneous flaps. These drains are often placed at the site of component separation in addition to a midline drain, for a total of three drains placed. However, the number and location of drain placement is surgeon dependent.
9. The midline skin incision is closed in layers in the usual fashion.
10. Placement of an abdominal binder is routinely performed, which is worn throughout the perioperative period up to 6 weeks postoperatively.

60.2.2 Advantages and Disadvantages of This Procedure

The anterior component separation must be given appropriate credit for achieving the goals of abdominal wall reconstruction while circumventing the morbidity encountered with myocutaneous flaps, free tissue transfer, and bridging mesh repair. Nevertheless, the anterior component separation technique is associated with wound morbidity rates as high as 40% due to the large subcutaneous flaps created and sacrifice of abdominal wall vasculature that is inherent to this procedure [9, 10]. Furthermore, this procedure has been associated with hernia recurrence rates as high as 20% [11, 12]. While this recurrence rate is lower than the historical rates of primary tissue repair, myocutaneous flaps, free tissue flaps, and bridging mesh repair, a long-term ventral hernia recurrence rate of 20% is still high to most surgeons and patients. This high recurrence rate is likely multifactorial and related to (1) the associated wound morbidity of this procedure and (2) the common use of biologic grafts at the time that this procedure was first adopted [13, 14].

60.3 Periumbilical Perforator-Sparing Anterior Component Separation Technique

60.3.1 Key Steps to the Procedure

1. The procedure begins with midline entrance into the abdominal wall cavity with lysis of adhesions performed, as needed.
2. The primary tenet of this procedure is to preserve the periumbilical perforating vessels that branch off the deep inferior epigastric vessels which supply the medial aspect of the abdominal wall. They typically occur within 3–5 cm of the umbilicus. Elevation of the skin and subcutaneous tissue off of the abdominal wall musculature is performed. *This part of the procedure is different from the originally described anterior component separation* and involves division of the subcutaneous tissue planes on either side of the midline into two parts—one superior to the umbilicus and one inferior to the umbilicus. The superior subcutaneous tissue plane is developed first. This begins at the superior aspect of the wound and ends approximately 5 cm above the umbilicus. The inferior subcutaneous tissue plane is then developed, starting at least 5 cm below the umbilicus and extending to just above the pubis. Both the superior and inferior subcutaneous flaps are extended to the anterior axillary line and connected at least 5 cm lateral to the umbilicus to allow for complete exposure of the linea semilunaris and external oblique aponeurosis (Fig. 60.2).
3. The linea semilunaris is identified. A vertical incision is made approximately 2 cm lateral to the linea semilunaris into the external

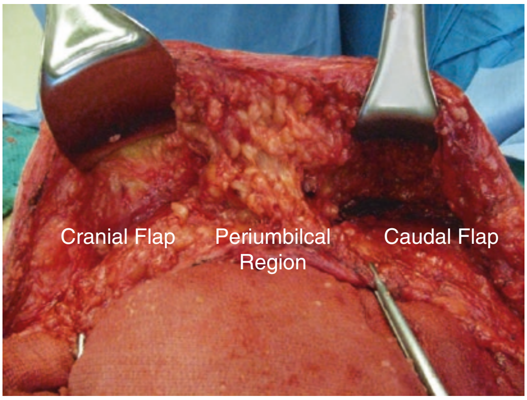

Fig. 60.2 Periumbilical perforator sparing anterior components separation technique. The skin and subcutaneous tissue within a 5 cm radius of the umbilicus is left intact with creation of a cranial and caudal flap. These flaps are connected along the lateral aspect of the abdominal wall in order to expose the linea semilunaris and the external oblique aponeurosis

oblique aponeurosis. This incision is advanced from the costal margin to the inguinal ligament.

4. The avascular plane between the external and internal oblique muscles is developed using blunt dissection, with extension to the anterior axillary line.
5. If additional mobilization is needed, the posterior rectus sheath should be incised approximately 0.5 cm from its edge, with dissection of the rectus muscle off of the posterior rectus sheath.
6. At this point, that ability to close the abdominal wall is tested. To do this, Kocher clamps are applied to the anterior rectus fascia on either side of the abdomen and pulled toward the midline. This modification to the original anterior component separation technique still separates the external oblique from the internal oblique and the posterior rectus sheath from the rectus abdominis muscle, which should allow for closure of defects up to 20 cm wide [15].
7. The decision for mesh reinforcement and the location of mesh placement is determined. The options for mesh placement and the considerations for mesh overlap of the linea alba are the same as for that of the anterior component separation technique.
8. Placement of closed suction drains for management of postoperative seroma/dead space in the setting of mobilization of lipocutaneous flaps. These drains are often placed at the site of component separation in addition to a midline drain, for a total of three drains placed. However, the number and location of drain placement is surgeon dependent.
9. The midline incision is closed in layers in the usual fashion.
10. Placement of an abdominal binder is routinely performed, which is worn throughout the perioperative period up to 6 weeks postoperatively.
11. There are other modifications that can be used during periumbilical perforator-sparing component separation, including making small counter incisions in the upper abdomen near the costal margin to gain access to the lateral abdominal wall in order to further decrease the subcutaneous flap size.

60.3.2 Advantages and Disadvantages of This Procedure

The periumbilical perforator-sparing anterior component separation was proposed as a means to decrease the ischemic midline wound morbidity associated with the original anterior component separation technique [15]. The theory behind this technique is that by preserving the perforator vessels to the umbilicus, there is a potential for improved midline wound healing due to adequate perfusion of the umbilicus, subcutaneous tissue, and underlying rectus muscle [16]. Nevertheless, large lateral subcutaneous flaps are still created in order to facilitate the component separation aspect of this procedure which is associated with significant dead space, and therefore the risk of seroma formation is relatively unchanged [9, 17]. Furthermore, the preserved perforator vessels can be within the redundant skin that is often excised during this procedure [16, 18].

60.4 Laparoscopic/Endoscopic Component Separation Technique

60.4.1 Key Steps to the Procedure

1. The procedure begins with midline entrance into the abdominal wall cavity with lysis of adhesions performed, as needed.
2. The surgeon and assistant then move to the same side of the operating room table in order to perform the laparoscopic component separation.
3. A 1 cm incision is made just inferior to the costal margin lateral to the rectus abdominis muscle.
4. Blunt dissection is used to divide the subcutaneous tissues until the external oblique muscle is identified.
5. The external oblique muscle is grasped with two Kocher clamps and incised in the direction of its fibers.
6. The fibers of the external oblique are divided until the internal oblique muscle is identified.
7. The avascular space between the internal and external oblique muscles is then developed using a laparoscopic inguinal hernia balloon dissector. Once this space is developed, a 10 millimeter (mm) balloon port is inserted through the original incision to maintain insufflation of 12 mm of mercury (Hg).
8. Two 5 mm ports are placed, one lateral to the umbilicus along the posterior axillary line and one just superior to inguinal ligament and lateral to the rectus abdominis muscle.
9. Using blunt dissection with laparoscopic tools, the space between the external and internal oblique muscles is developed lateral to the rectus abdominis muscle and medial to the posterior axillary line.
10. Once this space is developed, the linea semilunaris and the external oblique aponeurosis can be appropriately visualized. Using coagulating scissors, the external oblique aponeurosis is incised and released, beginning at the costal margin and extending to the inguinal ligament.
11. If additional mobilization is needed, the posterior rectus sheath should be incised approximately 0.5 cm from its edge, with dissection of the rectus muscle off of the posterior rectus sheath.
12. The original description of this procedure used intraperitoneal mesh placement for reinforcement of the hernia repair [9]. As previously discussed, one should keep in mind that the mesh will be in contact with the abdominal viscera and that it should be secured laterally on the abdominal wall under tension in order to prevent wrinkling of the mesh when the midline is brought back together.
13. Placement of closed suction drains is performed, often at the site of lateral component separation and one in the midline, for a total of three drains placed. However, the number and location of drain placement are surgeon dependent.
14. The midline and linea alba is recreated using a running, slowly absorbable suture.
15. The midline incision is closed in layers in the usual fashion.
16. Placement of an abdominal binder, which is worn throughout the perioperative period.

60.4.2 Advantages and Disadvantages of This Procedure

The major advantage to the endoscopic component separation technique is that the lateral compartment, including the external oblique and internal oblique muscles, can be directly accessed using minimally invasive techniques without the creation of large subcutaneous flaps [9, 17, 19, 20]. Direct access to the site of component separation preserves the perforator blood supply to the abdominal wall and minimizes dead space formation, effectively reducing the risk of postoperative wound events. Indeed, a recent meta-analysis comparing open component separation to endoscopic component separation revealed a statistically significant decrease in postoperative wound events following endoscopic component separation, with rates as low as 6% [18]. Furthermore, the endoscopic component separation technique is a viable option for patients with stomas since there is no shifting of the rectus abdominis muscle relative to the overlying skin [9, 19].

On the other hand, the endoscopic component separation technique has some disadvantages. First and foremost, the endoscopic component separation procedure requires advanced laparoscopic skills, which not all surgeons have or will adopt. Furthermore, mesh placement in an underlay or intraperitoneal position is more challenging that the commonly performed onlay position used in the open, anterior component separation procedure. Finally, when compared to the open, anterior component separation procedure, the endoscopic component separation technique can only achieve approximately 85% of the total fascial advancement achieved from the open, anterior component separation procedure [9].

60.5 Posterior Component Separation Technique

60.5.1 Key Steps to the Procedure

1. The procedure begins with midline entrance into the abdominal wall cavity with lysis of adhesions performed, as needed. For this portion of the procedure, it is more important than during the previously described techniques to preserve the peritoneum and posterior rectus sheath for recreation of the retrorectus/preperitoneal space later in the operation.
2. The posterior rectus sheath is incised, approximately 0.5 cm from its edge. This incision is typically started at the level of the umbilicus and carried superiorly to the costal margin and inferiorly to the pubis. Incision into the posterior rectus sheath is confirmed with identification of the rectus muscle through the incision (Fig. 60.3).

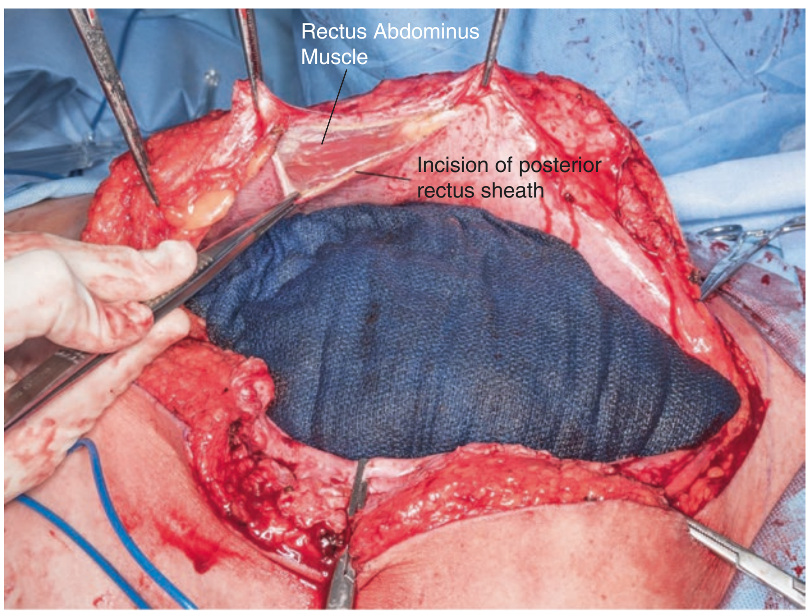

Fig. 60.3 Posterior components separation: incision of the posterior rectus sheath. Incision into the posterior rectus sheath, which is confirmed with identification of rectus abdominis muscle through the incision

3. Lateral dissection of the posterior rectus sheath is performed, using the tenants of traction and countertraction. Dissection of the posterior rectus sheath off of the rectus abdominis muscle occurs in this plane until the linea semilunaris is identified. Just medial to the linea semilunaris runs the neurovascular bundles and care must be taken during this portion of the dissection to preserve these bundles in order to maintain abdominal wall functionality and to prevent rectus muscular atrophy (Fig. 60.4) [21].
4. Mobilization of the posterior rectus sheath at the cephalad and caudad aspects of the dissection. The posterior rectus sheath joins with the anterior rectus sheath in the midline to create the linea alba. This insertion of the posterior rectus sheath at the midline must be released in order to facilitate communication of the retrorectus space across the midline.
5. Additional mobilization is performed into the pelvis, down to the space of Retzius, in order to join the posterior rectus sheath across the midline. The inferior epigastric vessels are used as landmarks during this aspect of the dissection. Dissection in this area proceeds similar to the dissection performed during a laparoscopic transabdominal preperitoneal inguinal hernia repair [21]. The lateral aspect of the dissection ends once the psoas muscle is identified.
6. At this point, one must determine if mobilization of the posterior rectus sheath is sufficient for abdominal wall closure. In order to do this, Kocher clamps are placed on either side of the posterior rectus sheath and brought to the midline. If the midline is reapproximated without excessive tension, the posterior rectus sheath is closed using a running absorbable suture. However, if there is undue tension with this maneuver, a transverse abdominis/posterior component separation is performed.
7. We typically begin the posterior component separation in the lower third of the abdomen. In this area, the posterior rectus sheath is

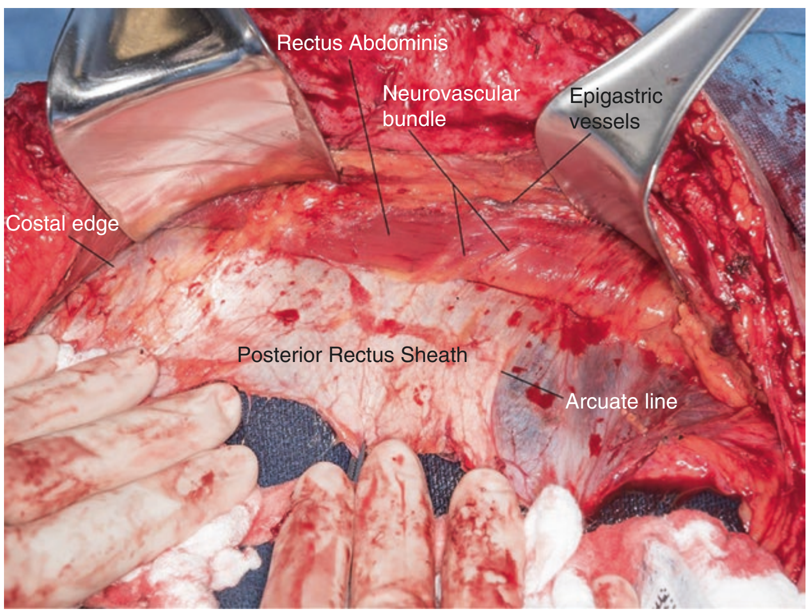

Fig. 60.4 Lateral extent of posterior rectus sheath dissection. The posterior rectus sheath is dissection off of the rectus abdominis muscle up to the linea semilunaris. This dissection exposes the neurovascular bundles which must be preserved in order to prevent rectus muscular atrophy

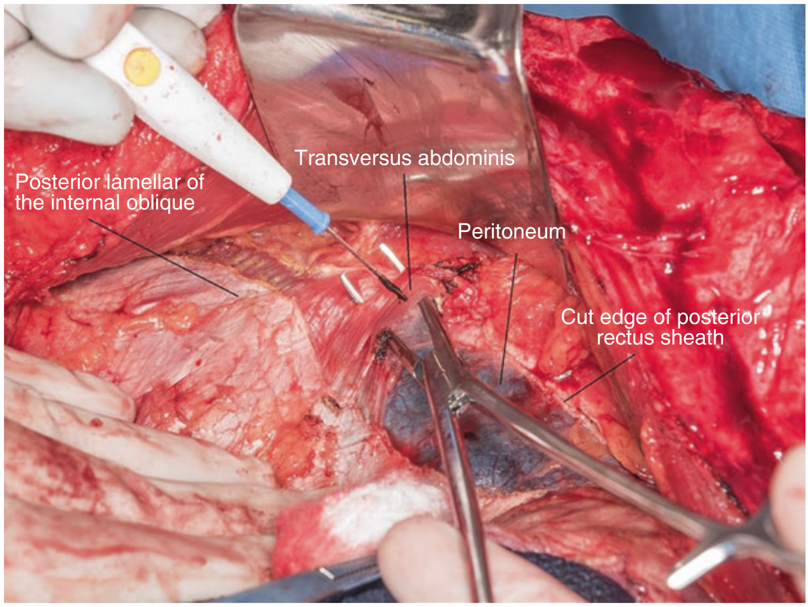

Fig. 60.5 Posterior components separation technique. If the hernia defect cannot be closed with mobilization of the posterior rectus sheath only, a posterior components separation is performed. This dissection begins in the lower third of the abdomen. Violation of the peritoneum is prevented using the tenants of traction and counter-traction and division of the fascia layer by later with the use of a right angle clamp

comprised of the transversalis fascia and the peritoneum. The incision begins just medial to the linea semilunaris and the neurovascular bundles, exposing the underlying peritoneum (Fig. 60.5). In order to prevent violation of the peritoneum, we use the tenants of traction and countertraction and divide the fascia layer by layer in a controlled fashion using a right angle clamp.

8. Once the release has been performed in the lower third of the abdomen, attention is turned toward division in the upper third of the abdomen. In this area, the posterior rectus sheath is actually comprised of the posterior lamella of the internal oblique and the transversus abdominis muscle. Beginning at the costal margin, both of these muscle structures are divided until the peritoneum is encountered. Again, the tenants of traction, countertraction, and controlled division of the musculature are performed in order to prevent violation of the peritoneum.
9. The posterior component separation is joined in the middle third of the abdomen, with dissection of the transverse abdominis muscle until the peritoneum is visualized.
10. A Kittner dissector is used to develop the preperitoneal plane laterally to the retroperitoneal space, superiorly to the diaphragm, and inferiorly to the psoas muscle and space of Retzius.
11. Once the posterior component separation is completed, abdominal wall closure is again tested. This is again performed by placing Kocher clamps on either side of the posterior rectus sheath and bringing them toward the midline. The posterior component separation should provide for closure of abdominal wall defects that are similar in size to those closed using the anterior component separation technique [11].
12. The posterior rectus sheath is closed using a running, absorbable suture.
13. Mesh reinforcement is performed with placement of mesh into the retrorectus space, above the posterior rectus sheath but below the rectus muscle. The mesh is often placed into a diamond configuration, and multiple transabdominal sutures are used to secure the mesh superiorly to the xiphoid, inferiorly to Cooper's ligament, and laterally.
14. Two closed suction drains are placed, one on either side of the abdomen, into the retrorectus space, above the mesh but below the rectus abdominis muscle.

15. The anterior rectus sheath is closed with a running, slowly absorbable suture for recreation of the linea alba.
16. The midline incision is closed in layers in the usual fashion.
17. Placement of an abdominal binder, which is worn throughout the perioperative period.

60.5.2 Advantages and Disadvantages of This Procedure

The posterior component separation technique provides for a durable hernia repair, with long-term recurrence rates of less than 10% reported in the literature [21]. The long-term durability of the posterior component separation technique is likely multifactorial and related to (1) decreased wound morbidity as the creation of large subcutaneous flaps is avoided and the perforating abdominal wall vessels are preserved and (2) the ability to place a large piece of prosthetic mesh in a well-vascularized plane [21, 22]. Nevertheless, the transverse abdominis muscle is intimately involved in core stability of the abdominal wall and the spine, and the long-term effect of this procedure on core stability remains unknown [23–25]. Additionally, the posterior component separation procedure is technically a demanding procedure and requires an advanced abdominal wall reconstructive skill set that not all general surgeons have.

Conclusion

Significant advances have been made in the field of complex abdominal wall reconstruction since the originally described component separation technique in 1990. Because each technique described has advantages and disadvantages, it is important for surgeons treating patients with large abdominal wall hernias to consider each repair on a case-by-case basis. Furthermore, despite the popularity of these procedures, these surgeries are not without morbidity, and they should be reserved for patients whose abdominal wall cannot be repaired in a standard fashion without the mobilization of myofascial components.

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