Chapter 6
Considerations in Abdominal Wall Reconstruction

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Defects of the abdominal wall have many etiologies, ranging from congenital malformations, trauma, burns, and radiation to those caused by surgical intervention for a variety of disease processes. The resultant defects can be broadly classified into partial thickness and full thickness defects depending on the components involved. Furthermore, the acuity of the wound could influence reconstruction options. Based on extent of the wound and involvement of adjacent structures, reconstructive maneuvers may range from simple primary closure to microsurgical free tissue transfer. For complex reconstructions, a collaborative approach between acute care, trauma, and plastic surgeons may yield the most durable, functional, and aesthetic outcomes.

Reconstruction of the abdominal wall requires a thorough understanding of the anatomy and function of the involved structures. The anatomic layers of the abdominal wall include the skin, subcutaneous tissue, superficial and deep fascia, muscle, extraperitoneal fascia, and peritoneum. The main muscles of the abdominal wall include the external oblique, internal oblique, transversus abdominis, and rectus

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F. G. Madbak, D. A. Dangleben (eds.), *Options in the Management of the Open Abdomen,* DOI 10.1007/978-1-4939-1827-0_6

abdominis muscles. These muscles serve to provide protection of the abdominal viscera and stabilization of the torso, while also playing a key role in movement and posture. The arterial supply to the abdominal wall consists of the superior and inferior epigastrics, superficial and deep circumflex iliacs, superficial external pudendals, intercostals, and lumbar vessels. Innervation to the abdominal wall is from the ventral rami of T7 through L4, the iliohypogastric, and ilioinguinal nerves.

Prior to embarking on any attempt at abdominal wall reconstruction, an initial thorough review of the patient's history is mandatory. Particularly, the surgeon should elicit comorbidities, past surgical history, tobacco use, previous radiation, and medications. The examination should focus on which noting structures are absent, whether the defect is midline or lateral, as well as the presence of any surrounding scars that may compromise attempts at local flap reconstruction. Vascularity of adjacent tissues should be assessed as this is especially important when using underlying prosthetic materials. Additional attention during the preoperative evaluation should focus on the presence of an enterostomy, enterocutaneous fistula, contamination, or infection.

Ideally, closure should be tension-free in an effort to prevent tissue necrosis or fascial dehiscence. However, when this is not possible, the interpositional use of biologic materials is recommended. Introduced in Chap. 5 and discussed in more detail below, these adjuncts are significantly easier to salvage when exposed or infected in contradistinction to prosthetic agents. Management of the open abdominal wound presents numerous challenges: bowel edema, continued sepsis, and loss of abdominal domain. Skin grafting and tissue expansion should be avoided, when possible, as they require multiple operative procedures, with their inherent associated morbidity.

Details of the techniques for management of the complex abdominal wall defect are discussed in other chapters. However, a collaborative approach to abdominal wall reconstruction is typically most effective. Plastic surgeons may offer alternatives such as local, regional, or free flap reconstruction. In some situations, these options may be unavailable, secondary to either limited familiarity with these techniques or unavailability of the requisite equipment. In these settings, a broad range of relatively simpler options exist to successfully manage abdominal wounds in one or multiple stages.

Prosthetics and Adjuncts in Abdominal Wall Reconstruction

The word prosthetic is derived from the Greek word *prostithenai* (from *pros* "add to" and *tithenai* "to put/place"). In modern times, it is defined as "an artificial device to replace or augment a missing or impaired part of the body." Originally, prostheses for abdominal wall reconstruction were meshes created from various types of wire. In the 1940s and 1950s, tantalum mesh and stainless steel were both described for use as prosthetics in abdominal wall reconstruction but quickly abandoned because of numerous complications. Nylon, fiberglass, and Teflon are all examples of other materials that have been used. The development of plastic in the twentieth century allowed for creation of meshes which were lighter and more flexible. These later became the prosthetics of choice [1–3].

To reconstruct the abdominal wall, one can refer to the "reconstructive ladder"—a series of options for wound closure, ranked from the least to most invasive. Autologous tissue, however, is typically described as the "gold standard" for abdominal wall reconstruction, as it is associated with fewer of the common complications seen with implantable prostheses such as infection, hematoma, seroma, fistula, and extrusion. Synthetic meshes are prone to infection in grossly contaminated fields, thus precluding their use. The advent of biologic mesh has reduced the infectious complications seen with synthetics based on the premise that they can safely be used in contaminated wounds.

Synthetic Mesh

Synthetic meshes were the first prostheses used in abdominal wall reconstruction, and have continued to develop since their introduction in the mid-twentieth century. Although there have been many advances in mesh materials, there is no "one-size-fits-all" mesh. Ideally, a synthetic mesh should be nontoxic, resistant to infection, and immunologically inert [1]. Currently, there is no prosthetic mesh that exhibits all of these properties. However, most synthetic meshes are strong and pliable, making them useful for abdominal wall reconstruction in clean cases.

Most meshes have a tensile strength that is twice that necessary for the average abdominal repair; paradoxically, hernias still recur. True breakdown of these repairs most commonly occurs at the tissue–mesh interface. Thus, the material, the quality of the fascia to which the mesh is fixated, and the strength of the interface are some of the most important qualities in an abdominal wall reconstruction.

There are many intrinsic properties that can determine the success of a mesh repair (Table 6.1). Porosity is frequently noted as one of the most important intrinsic properties of synthetic meshes. Macroporous meshes ($> 75\ \mu$) allow for macrophage and neutrophil infiltration, better vascular ingrowth, and collagen deposition and incorporation. Macroporous meshes are also lighter and more flexible, which inevitably improves quality of life postoperatively. Meshes with smaller pores ($< 10\ \mu$) have decreased incidence of bowel adhesions and injury; however, they allow bacteria to enter the prosthetic and prevent inflammatory cells from entering, thus inhibiting the immune response. This can lead to a higher incidence of infection [4].

Polypropylene material is one of the most commonly used synthetic meshes. It is nonabsorbable and popular for its macroporous structure. It is advantageous because of better fibrovascular ingrowth and immune cell penetration. It also leads to stronger scar formation, creating a more durable apposition with the fascial edge [5]. These meshes create a stiff scar due to the lack of pliability. This can be useful to cover large defects of the abdominal wall where there is little support. The

Table 6.1 Classification of prosthetic mesh based on pore size

Type	Porous structure	Examples
Type I	Macroporous (>75 μ)	Marlex[a], Prolene[b] Trelex[c]
Type II	Microporous (<10 μ in at least one direction)	ePTFE, Dual-Mesh[d]
Type III	Macro and microporous	PTFE[d], Mersilene[b] Surgipro[e]
Type IV	Submicronic pore size	Silastic sheeting, Celgard[f]

[a] Bard, Murray Hill, NJ
[b] Ethicon, Somerville, NJ
[c] Boston Scientific, Natick, MA
[d] Gore, Newark, DE
[e] Covidien, Mansfield, MA
[f] Polypore, Charlotte, NC

macroporous structure also allows for neutrophil and macrophage migration into the mesh, thereby allowing clearance of bacteria [1, 4]. More common complications include mesh extrusion or erosion into bowel.

PTFE/ePTFE (Gore-Tex, W.L. Gore, Newark, DE) is another nonabsorbable mesh. It is stronger than polypropylene but also flexible. The expansion process of PTFE creates a material that is relatively inert when implanted. The small pore size accounts for a minimal foreign body reaction compared to polypropylene and accounts for its advantages and disadvantages [5]. There is less risk of the mesh erosion through the skin or viscera due to its microporous structure and can be placed directly over the exposed bowel. The small pore size does predispose this implant to seroma formation, as this fluid cannot adequately egress through the mesh. Similarly, formation of fluid can increase the risk of abdominal compartment syndrome [6]. It also allows smaller bacteria (1 μ in size) to migrate into the mesh but does not allow entry of inflammatory cells, such as macrophages (greater than 50 μ). This, along with the lack of fibrovascular ingrowth, predisposes the implant to infection, which would ultimately mandate mesh removal.

Alternative options include polyglactin-based meshes (e.g., Vicryl, Ethicon; Dexon, Davis & Geck, Sugarland, TX) which are absorbable. Their primary advantage is use as a temporary solution in grossly contaminated wounds. Polyglactin-based options retain their strength in the short term, have a decreased risk of fistula formation, and allow fluid drainage. They are usually not used for long-term or permanent reinforcement as a result of progressive loss in tensile strength over time.

Composite meshes (e.g., Vypro I/II, Ultrapro, Proceed, Ethicon, Somerville, NJ; Sepramesh and Composix, Bard, Murray Hill, NJ) are also available for repair of abdominal wall defects. The primary advantage of composite meshes is that one side of the mesh prevents adhesions to adjacent bowel, while the other provides strength and support to the abdominal wall. These meshes offer a great option for the abdominal wound with exposed viscera; however, the anti-adhesive layer can develop marginal breakdown, leading to adhesions. Also, the permanent materials in these prostheses can become infected if bacterial seeding occurs.

The major drawbacks to the use of synthetic mesh are infection and seroma formation. Seroma formation is common and is usually the result of extensive dissection and creation of dead space. Seromas of the abdominal wall are typically managed with observation; however, if drainage is necessary, it is imperative to obtain a fluid culture. Observed in large series of laparoscopic ventral hernia repair experience, aspiration of seromas has the risk of introducing bacteria, resulting in infection and the recurrence of the hernia. Usually, expectant management is all that is required. Hematomas can also occur and are treated in the same fashion. Hematomas require treatment if actively bleeding, expanding, or infected.

Infection is the most feared complication and usually necessitates prosthetic explantation. This is most commonly due to surgical wound infection that tracks the underlying mesh, resulting ultimately in mesh extrusion. Every attempt should be made to cover the mesh with well-vascularized tissue to decrease the incidence of these complications.

Biologic Mesh

Biologic mesh materials are derived from human or animal tissue. Human dura, dermis, muscle, fascia, small intestine submucosa, porcine dermis, amniotic membranes, and pericardium have all been used in the past as a biologic mesh prosthetic. Chemical treatments are used to minimize associated foreign body reaction. They are incorporated into native tissue by the host inflammatory cascade and continue to undergo remodeling over time. Less concern for complications has been noted even when placing these materials in infected fields or with inadvertent enterotomies or serosal injury. As previously mentioned, routine use of biologic mesh is still difficult to justify, given their high cost and the lack of long-term data. Still, they are an excellent option in complicated abdominal wall defects.

AlloDerm (Lifecell, Branchburg, NJ) and Allomax (Bard, Murray Hill, NJ) are two of the most popular biologic regenerative tissue matrices which consist of non-cross-linked human dermal collagen matrices. The dermal matrix is treated with sodium chloride and sodium deoxycholate to remove living cells, leaving behind extracellular matrix. Acellular human dermis has numerous applications, ranging from incisional and ventral hernia repairs to abdominal and chest wall reconstruction. It is advantageous because of its rapid vascularization, allowing complete incorporation to occur in as little as 4 weeks. Additionally, the large pore size allows fluid to flow freely, consequently decreasing the risk of seroma or increasing intra-abdominal pressure.

Compared to other biologic prostheses, acellular dermal matrix has been shown to have lower rates of hernia recurrence, seroma, and wound infection. Local wound care resolves most cases of dermal matrix exposure and wounds usually heal by secondary intention. FlexHD (Ethicon, Somerville, NJ), a less commonly used acellular dermal matrix, is another available product. In contrast to early versions of Alloderm and Allomax, FlexHD does not require refrigeration and is readily available for instant use.

Surgisis (Cook Medical, Bloomington, IN) is made of porcine small intestinal submucosa. Historically, it was used for arterial bypass, ACL repair, and bladder slings. It is available in a perforated and non-perforated form. The perforated version facilitates vascular ingrowth, but is also more adhesiogenic as compared to the non-perforated alternative. Surgisis has a tensile strength greater than two times the strength of native tissue and has been shown to have almost five times the strength 2 years after repair [7]. Other studies did show higher rates of infection when it was used in highly contaminated wounds or in critically ill patients. Surgisis is an excellent choice in clean-contaminated cases where surgeons would prefer to avoid a synthetic mesh.

Permacol (Covidien Surgical, Mansfield, MA) is an acellular porcine dermis which is decellularized and chemically cross-linked to inhibit breakdown of the collagen matrix. It creates less foreign body reaction than Surgisis and the collagen is resistant to degradation. Small case series supports its use in infected areas with contamination; however, there is little long-term outcome data. XenMatrix (Bard, Murray Hill, NJ) is another porcine dermis-derived biologic mesh and is not cross-linked (Bard Davol). The lack of cross-linking may contribute to the high rates of infiltration and remodeling in this material when compared to Permacol. In contrast to human-derived dermis options, Permacol appears relatively more rigid.

Technique

Options for the placement of mesh include an underlay, an inlay, or an onlay technique. Though several approaches are feasible, evidence has shown that technique is one of the primary factors driving hernia recurrence. While intraperitoneal placement has been described, it is preferable to avoid mesh contact with bowel if possible.

The underlay technique is defined as an intraperitoneal placement of the prosthesis (Fig. 6.1). This is the preferable method of placement because intra-abdominal pressure will push the prosthetic against the rectus abdominis and its overlying fascia. In addition, there is a large amount of surface area in contact between the mesh and the fascia [8]. As a result, we believe the underlay technique has the lowest incidence of recurrent herniation. It also has the lowest rate of infection and wound breakdown due to the greater soft tissue protection from skin flora and environmental contaminants.

Inlay placement is defined as a bridge of prosthetic mesh between the edges of the rectus fascia (retrorectus and preperitoneal). This method usually has an unacceptably high incidence of recurrent hernia (up to 75 %) [9]. This is likely due to a small total contact area between the mesh and fascia, which leads to a weaker repair.

Onlay is placement of the mesh superficial to the fascial repair. There is less fibrovascular infiltration of the mesh in this position, and it is closer to the skin, making this method the most likely to have wound complications. The onlay technique requires dissection in the subcutaneous plane which may lead to seroma formation (Fig. 6.2). Furthermore, division of blood supply to the overlying skin can lead to

Fig. 6.1 Underlay placement of dermal matrix

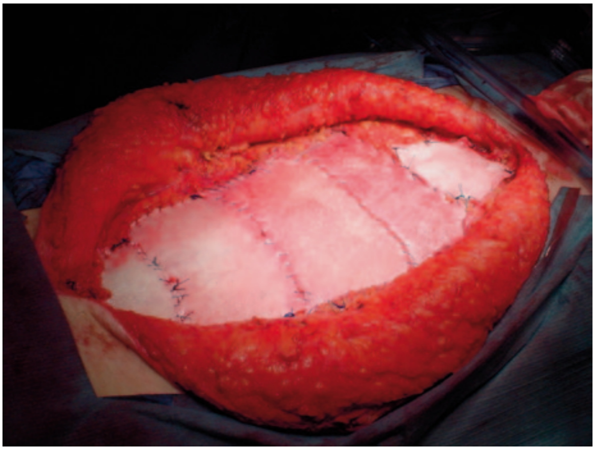

Fig. 6.2 Onlay placement of dermal matrix

skin necrosis, breakdown, and subsequent prosthetic infection. However, the onlay technique does avoid the risk of visceral adhesion formation or more importantly bowel erosion and fistula formation.

Vacuum-Assisted Closure

Vacuum-assisted closure (VAC) or negative pressure wound therapy (NPWT) is a commonly used technique in the management of open abdominal wounds. Negative pressure is applied to a wound through a sponge system usually at a pressure of −125 mmHg. The VAC has great success if infection is controlled, necrotic tissue is debrided, and bacterial counts are minimized. Gross infection, presence of necrotic tissue, and residual neoplasia are contraindications to the use of VAC therapy.

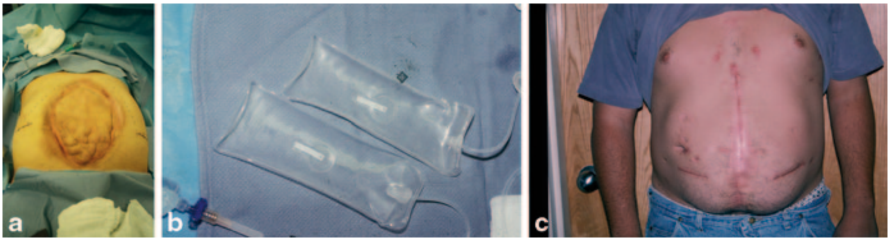

Fig. 6.3 **a–c** Use of tissue expansion in the closure of an abdominal wall defect. Final result is shown in **c**

The VAC can remove a large amount of fluid in a short period of time. This allows for faster and improved wound healing as tissue edema decreases and soft tissue perfusion increases. Research has shown stimulation of granulation tissue and fibrovascular ingrowth allowing for better wound healing and a favorable wound bed, should a skin graft be needed for wound coverage. Bacterial counts are significantly decreased with VAC therapy, which greatly assists wound closure. VAC therapy also limits repeated operative interventions and allows wounds to be temporized, while optimizing patients for definitive surgery [10].

Tissue Expansion

In the presence of significantly large soft tissue defects in the abdominal wall, tissue expanders are a viable option for reconstruction (Fig. 6.3). Hollow prosthetics are implanted into soft tissue and gradually filled with saline to produce tissue recruitment and growth overlying the expander. They help recruit and provide autologous tissue that is well vascularized and has adequate innervation, which is ideal for abdominal wall reconstruction.

The major drawback to tissue expansion is the long period of time required for expansion and patient discomfort during the expansion period. Additionally, it is frequently inconvenient, as the expander must be placed overlying firm areas such as the chest wall, the iliac crest, or the lumbar fascia. Furthermore, expanders have a propensity to become infected, especially in an already compromised abdominal wound. This technique is not frequently used and should be considered only when options are limited or tissue defects are substantial [11].

Autologous Options for Abdominal Wall Reconstruction

The use of autologous tissue is always preferable to the use of foreign materials in wound healing. This holds especially true in wounds from trauma or surgical wounds complicated by infection or radiation. As mentioned, abdominal wall reconstruction by non-autologous means has higher incidences of fistula formation, extrusion, and infectious complications (see Chap. 8) [12–13]. Undoubtedly, the ideal closure for any type of wound, including the open abdominal wound, is primary closure. When primary fascial closure is not possible, there are several strategies that can be used in this scenario to achieve wound closure without the use of foreign materials. Each of these options has distinct advantages and disadvantages.

Skin Grafting

Skin grafting has a limited role in the reconstruction of the anterior abdominal wall due to poor cosmesis and lack of structural support. It can, however, be used as a temporizing measure to provide reliable coverage of abdominal wall defects and assist in wound healing. Ultimately, patients who undergo skin grafting will require a subsequent staged procedure to reestablish abdominal wall integrity.

Skin grafting should be performed on healthy, noninfected tissue with an adequate wound bed (i.e., healthy granulation tissue). A skin graft can be placed directly on viscera or on omentum, if necessary [14]. Skin grafts should not, however, be applied to exposed prosthetic mesh. The recipient wound bed should have less than 10^5 bacterial colonies per gram of tissue for a skin graft to survive [15]. Split thickness skin grafts (STSG) should be meshed before placement on the wound to both maximize the size of the STSG and increase chance of "take." STSG are usually harvested from an inconspicuous location such as the upper lateral thigh, the buttock, and/or the hair-bearing scalp. In the first 24 h postoperatively, skin grafts survive by imbibition, but for the following 2–10 days, inosculation and new vascular ingrowth will provide permanent vascular support to the skin graft.

Component Separation

Described in more detail in the previous chapter, [16, 17] abdominal component separation is currently one of the most common methods employed by surgeons to achieve reliable abdominal closure with autologous tissue. First described by Ramirez in 1990, this method not only provides reliable abdominal closure but also helps recreate a functional and dynamic anterior abdominal wall by using innervated myofascial flaps. Some believe that a dynamic reconstructed abdominal wall is better able to resist strain and redistribute tension forces evenly throughout the abdominal wall, yielding a lower rate of hernia recurrence and limiting poor functional sequelae.

The original technique described by Ramirez has since undergone many modifications, with each modification improving upon the original description. The cornerstone concept of any component separation is creation of the rectus abdominis-internal oblique-transverses abdominis muscle complex. Creation of this complex is the essential maneuver that allows for a tension-free abdominal closure. Generally, component separation can provide approximately 5 cm of mobility from each fascial edge at the costal margin, 10 cm of mobility from each fascial edge at the waistline, and 3 cm of mobility from each fascial edge at the suprapubic region. This yields bilateral advancement of 10 cm at the costal margin, 20 cm at the waistline, and 6 cm at the suprapubic region [12, 16, 17].

Drawbacks to the use of component separation include a relatively high rate of hernia recurrence (between 10 and 30 %), high rate of infection, potential skin and subcutaneous tissue loss from extensive undermining of skin flaps [12, 18] (approximately 20 %), and interference with enterostomies when advancing muscle under skin flaps. The high rate of hernia recurrence has been attributed to the complexity of the hernias that are reconstructed using this technique as well as field contamination at the time of surgery. In patients requiring abdominal wall reconstruction that have concurrent enterostomies, it is our practice to do a staged procedure consisting of ostomy reversal and reestablishment of gastrointestinal continuity prior to embarking on definitive separation of components after several months. In patients that have inflammatory bowel disease that predispose them to fistula formation (e.g., Crohn's disease), one may choose to use biologic mesh for reconstruction because of the risk of seeding, should a fistula develop. Endoscopic techniques (see Chap. 6) continue to evolve and have shown promising results thus far.

Moreover, whereas it is acceptable to use synthetic mesh in open component separation reconstruction, some surgeons utilize biologic mesh empirically because of the high infection rate. One promising option to curtail the high cost of biologics is utilizing Phasix, a new mesh available from Bard Davol. This is a fully absorbable mesh designed to limit seroma formation and avoid permanent foreign material implantation, while providing a strong, durable repair. Constructed from monofilament poly-4-hydroxybutyrate, it has handling properties similar to that of polypropylene and is designed to retain higher strength for a longer period of time than some other fully resorbable materials based on preclinical data. Long-term studies are pending.

Technique

The defect must be completely defined initially and the hernia sac should be excised. Once the fascial edges are cleared of adhesions, skin flaps are elevated from the anterior abdominal musculature to the level of the anterior axillary line. A vertical incision is made parallel to and 2–3 cm lateral to the linea semilunaris, releasing the external oblique from the underlying internal oblique and the transverses abdominis muscle. This vertical incision extends from the level of the inguinal ligament to the costal margin. The plane beneath external oblique is developed towards the midaxillary line. Though this plane is avascular, one must be careful not to violate the internal oblique muscle so as to not disrupt the neurovascular bundles that supply the rectus abdominis muscle and sensory branches of the abdomen that run in the plane between the internal oblique and the transverses abdominis muscle. Next, the rectus abdominis muscle is dissected away from the posterior rectus sheath, starting at the medial border of the muscle and working laterally to the edge of the rectus muscle. Once this is accomplished, the rectus abdominis-internal oblique-transverse abdominis muscle complex is created.

The midline defect could then be closed by approximating the two edges of the rectus abdominis muscle with its anterior rectus sheath en masse. The skin flaps are then closed in a multilayer technique with placement of closed suction drains between the skin flaps and the external oblique muscles. An abdominal binder is usually applied for comfort and to minimize seroma formation. The drains can be discontinued after output is less than 20–30 ml of fluid over a 24-h period.

Local and Distant Muscle and Fascial Flaps

Local and distant muscle flaps provide autologous tissue for wound closure. This is beneficial with respect to dynamic support, coverage in contaminated fields, or coverage of exposed mesh. Local flaps could be principally useful for the reconstruction of lateral abdominal wall defects. The workhorse flap for these defects is the rectus abdominis muscle. With a dual dominant vessel blood supply, the rectus abdominis muscle can be based off of either an inferior pedicle from the deep inferior epigastric artery or from a superior pedicle from the superior epigastric artery. For defects located in the upper lateral abdomen, the rectus abdominis muscle should be based off of the superior epigastric artery. Similarly, the deep inferior epigastric artery is used as the pedicle for lower lateral abdominal wall defects.

Less commonly utilized local flaps include the external oblique muscle and the internal oblique muscle. The external oblique muscle is preferably used in the upper abdomen. However, this is not an ideal local flap due to the tenuous segmental blood supply from the posterior intercostal arteries. The internal oblique muscle can be used to reconstruct the lower abdomen and groin area. The blood supply to the internal oblique arises from segmental branches of the intercostal arteries and from the ascending branch from the deep circumflex iliac artery.

Distant muscle flaps can also be used when local tissue is not adequate for a local muscle flap or if the local flap has limited reach. For lower abdominal wall reconstruction, one of the most commonly used flaps is the tensor fascia lata (TFL) flap. This muscle, which is supplied by the lateral femoral circumflex artery, spans from the anterior superior iliac spine to the lateral aspect of the knee. Additionally, an overlying skin paddle can be included with the flap to provide skin and subcutaneous tissue to an area lacking adequate skin for closure. This skin paddle can measure up to 15×40 cm in dimension. Drawbacks to using this muscle flap include distal tip necrosis of the flap and donor site morbidity with wound infection and dehiscence.

Another reliable option for lower abdominal wall defects is the rectus femoris flap. It can be harvested with fascia and skin. The blood supply to the rectus femoris muscle is the lateral femoral circumflex vessels. This muscle originates from the anterior superior iliac spine and inserts into the patellar tendon. Reapproximation of the quadriceps tendons is necessary to maintain the terminal 15° of knee extension [14].

The main distant muscle flap used for upper abdominal wall defects is the latissimus dorsi muscle flap. This muscle has a reliable vascular anatomy and is supplied by the thoracodorsal artery. A skin paddle can also be included with this muscle to fill soft tissue voids. Limitations of this muscle flap are little fascial support for the prevention of hernia and donor site morbidity from the loss of latissimus dorsi, a powerful arm adductor. However, unless the patient is a competitive athlete, most will not be significantly affected from loss of the latissimus dorsi muscle [14].

Alternatively, fascial flaps have been utilized for abdominal wall reconstruction, most commonly the pedicled anterior lateral thigh (ALT) flap. This flap is based on the descending branch of the lateral circumflex femoral artery which is a branch of the superficial femoral artery. Perforators from the descending branch of the lateral femoral circumflex artery are dissected out through a septum between the rectus femoris and vastus lateralis. Sometimes these vessels traverse through the substance of the vastus lateralis creating a more difficult dissection of the perforators. The skin paddle can measure up to 8 × 20 cm; however, skin grafting is often required to cover the donor site when large skin paddles are harvested. Additionally, portions of the vastus lateralis and the investing fascia of the thigh can be included to provide fascia for closing abdominal wall defects deficient in fascia. Mesh can also be used in an underlay fashion to provide extra reinforcement to the abdominal wall in clean/non-contaminated cases.

Aside from the cosmetic defect, the donor site causes minimal morbidity due to the fact that the muscle is spared. The flap is most useful in reconstruction of the lower third of the abdomen based on the arc of rotation from the origin of the pedicle just inferior to the inguinal ligament. In some instances, bilateral ALT flaps are needed to provide enough soft tissue coverage for significant abdominal wall defects.

Free Flaps

The use of free flaps in the reconstruction of abdominal wall defects is recommended for abdominal wall defects complicated by extensive size, infection, radiation, and defects that cross the midline. A free flap is often selected because of inadequate local flaps whose blood supply has been compromised by previous abdominal surgeries. One distinctive advantage of free muscle transfer over pedicled muscle transfer is the ability to orient the muscle fibers to the vector of force. Additionally, skin and subcutaneous tissues can be included with the free muscle transfer, thereby facilitating closure of complex abdominal wounds. Furthermore, free flaps can aid in the closure of the abdomen as a one-stage procedure due to the addition of tissue to an abdomen that has lost domain. The addition of tissue results in less risk of developing abdominal compartment syndrome. The major drawbacks to using free flaps for abdominal wall reconstruction include a longer procedure time, potential donor site morbidity, atrophy of denervated muscle included in the free flap, and donor site cosmesis.

Since its first description in 1983, the TFL has become the most commonly used free flap for reconstruction of the lower abdomen. The vascular supply is derived from the lateral femoral circumflex artery. The motor branch of the femoral nerve can be included with the TFL to create a dynamic repair. The anatomy of this flap is reliable and makes for a consistent dissection. Skin and subcutaneous tissue can be included if there is a soft tissue defect requiring skin coverage. Skin paddles can measure up to 28 × 22 cm. It is important to orient the muscle and fascia perpendicular to the fibers of the rectus abdominis muscle. This assists in providing adequate tensile strength. Major concerns with this muscle flap include distal tip necrosis and donor site morbidity from wound infection and dehiscence from excessive tension. Skin grafting of the donor site, when necessary, may prevent wound dehiscence [19].

The rectus femoris free flap is also a good option when reconstructing the lower abdominal wall. If the rectus femoris motor nerve is preserved and coapted to one of the motor nerves of the abdominal wall, the dynamic properties of the abdominal wall will be reestablished and add to the strength of the reconstruction. Additionally, some advocate using this muscle in conjunction with TFL, utilizing the TFL for fascial strength and the rectus femoris for functional muscle. This method creates an anatomic repair similar to the native rectus abdominis/rectus sheath. The vascular supply of the rectus femoris is the lateral femoral circumflex artery. Once harvested, the vastus medialis and vastus lateralis should be approximated to avoid problems with terminal extension of the knee. Additionally, donor site cosmesis may be a limitation to the use of this flap.

The latissimus dorsi muscle free flap is considered a workhorse muscle flap in many realms of plastic and reconstructive surgery. Similarly, the reliable anatomy of this muscle flap makes for a reproducible dissection. This muscle flap also has the capability of being transferred as a functional muscle. Most surgeons would recommend using a prosthetic mesh under the muscle flap to aid with fascial support. Limitations of this muscle flap are similar to the limitations when used as a pedicled muscle flap.

The ALT perforator free flap is useful for abdominal wall reconstruction in that it has a reliable blood supply and a large skin paddle that can be used to cover large abdominal wall defects (Fig. 6.4). This flap is a fasciocutaneous flap containing only fascia, subcutaneous tissue, and skin. No muscle is included in this flap, thus conferring less morbidity. As an alternative, this flap can be transferred in conjunction with the TFL or the investing fascia of the thigh which will provide strength to the repair.

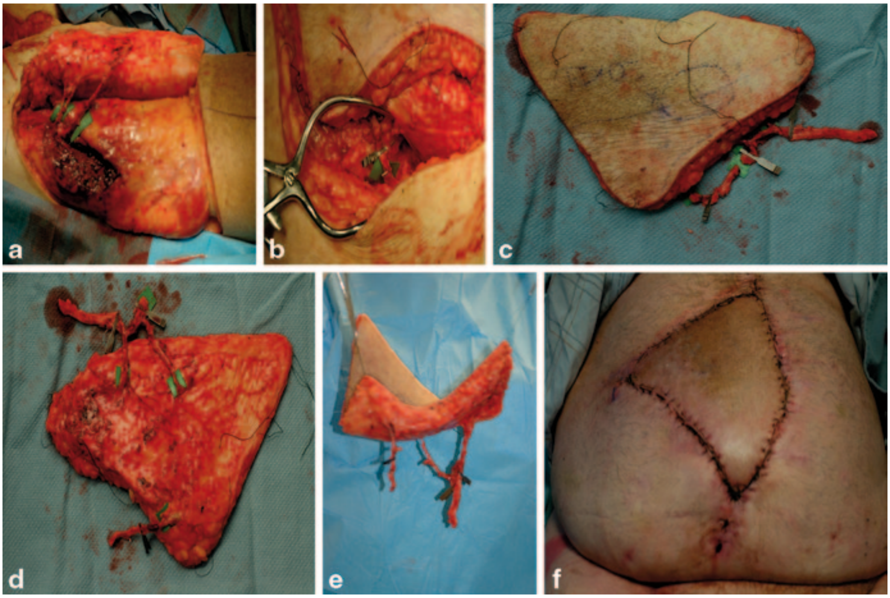

Fig. 6.4 **a**–**e** Free anterolateral thigh flap after measurement, dissection and elevation. **f** Free anterolateral thigh flap inset for reconstruction of an abdominal wall defect

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