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Planned Hernia Repair and Late Abdominal Wall Reconstruction

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Abstract Planned ventral hernia is a management strategy in which the abdominal fascial layer has been left unclosed and the viscera are covered only with original or grafted skin. Leaving the fascia open can be deliberate or unavoidable and most commonly results from staged repair of the abdominal wall due to trauma, peritonitis, pancreatitis, abdominal vascular emergencies, or abdominal compartment syndrome. The abdominal wall defects can be categorized as type I or II defects depending on whether there is intact, stable skin coverage. In defects with intact skin coverage, the most commonly used methods are the components separation technique and a prosthetic repair, sometimes used in combination. The advantages of the components separation technique is the ability to close the linea alba at the midline, creating a better functional result than a repair with inert mesh. Although the reherniation risk seems higher after components separation, the risk of infection is considerably lower. With a type II defect, with absent or unstable skin coverage, fascial repair alone is inadequate. Of the more complex reconstruction techniques, the use of a free tensor fasciae latae (TFL) flap utilizing a saphenous vein arteriovenous loop is the most promising. The advantages of the TFL flap include constant anatomy of the pedicle, a strong fascial layer, large-caliber vessels matching the size of the AV loop, and the ability to use large flaps (up to 20 × 35 cm). Whatever technique is used, the repair of complex abdominal wall defects requires close collaboration with plastic and abdominal surgeons, which is best managed in specialized centers.

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Introduction

Planned ventral hernia repair refers to a management strategy where the abdominal fascial layer has been left unclosed and the viscera are covered with original or grafted skin. In patients with open abdomens, the aim is to achieve primary fascial closure as soon as possible, but sometimes it cannot or should not be attempted [1]. Leaving the fascia open can be deliberate or unavoidable; it most commonly results from staged repair of the abdominal wall due to trauma, peritonitis, pancreatitis, abdominal vascular emergencies, or abdominal compartment syndrome. In these situations, the hernia is a favorable outcome with the aim of repairing the hernia at a later stage when it is safe, possible, and tolerated by the patient.

Depending on the type of skin coverage over the viscera, the abdominal wall defects can be categorized as a type I or II defect [2]. With the type I defect there is intact or stable skin coverage, whereas type II defects have absent or unstable skin coverage. In type I defects with stable skin coverage, bridging the fascial gap with prosthetic material or autologous tissue is the most frequently applied method. In type II defects with absent or unstable skin coverage, fascial repair alone is inadequate, and it needs to be covered with skin, requiring more complex reconstruction techniques. The criteria for special reconstruction techniques

include a large (40 cm^2) defect, absence of stable skin coverage, recurrence of the defect after prior closure attempts, infected or exposed mesh, systemic compromise (intercurrent malignancy), local tissue compromise (irradiation, corticosteroid dependence), or concomitant visceral complications (e.g., enterocutaneous fistula) [2].

The aims of this review were, first, to describe the three most commonly used repair techniques after a planned ventral hernia repair: components separation, mesh, free flap repair and the other aims were to outline the results of each technique and define the indications for the use of those techniques.

Components separation

The essential surgical technique in the components separation procedure is the creation of a musculofascial rectus abdominis component that can be mobilized laterally and brought to the midline. Although various methods to close the midline defects with sutures and fascial flaps were described by Guillouid in 1892, Chrobak in 1892, Gersuny in 1893, and Noble in1895, it was Alfonso Albanese in 1951 who described the method of dividing the external oblique muscle vertically to enable closure at midline by suturing together the rectus abdominis muscles [3]. However, it was not widely known or used until rediscovered and popularized by Ramirez and coworkers in 1990 [4]. They used fresh cadavers to demonstrate that the external oblique muscle can be separated from the internal oblique muscle in a relatively avascular plane, and that the compound flap of the rectus muscle with its attached internal oblique–transversus abdominis muscle can be advanced 10 cm around the waistline. They subsequently used the technique during reconstruction of abdominal wall defects in 11 patients with defects sizes ranging from 4 × 4 to 18 × 35 cm.

In the most commonly used modification, the external oblique muscle is divided on both sides vertically about 2 cm laterally to the lateral edge of the rectus sheath; the muscle is separated along the avascular plane from the internal oblique muscle, thus creating two rectus abdominis–transversus abdominis–internal oblique muscle flap complexes that can be advanced medially and sutured together at midline (Fig. 1). To further facilitate the mobility of the muscle flap complex, the posterior rectus muscle fascia can be divided at the middle part of the muscle (Fig. 2), providing additional fascial translation of about 2–4 cm [5]. To avoid unnecessary tissue trauma and the sacrifice of perforating vessels required by the extensive subcutaneous dissection over the anterior rectus muscle fascia, the division of the external oblique muscle can also be performed through small separate incisions using open (Fig. 3) or laparoscopy-assisted techniques [6].

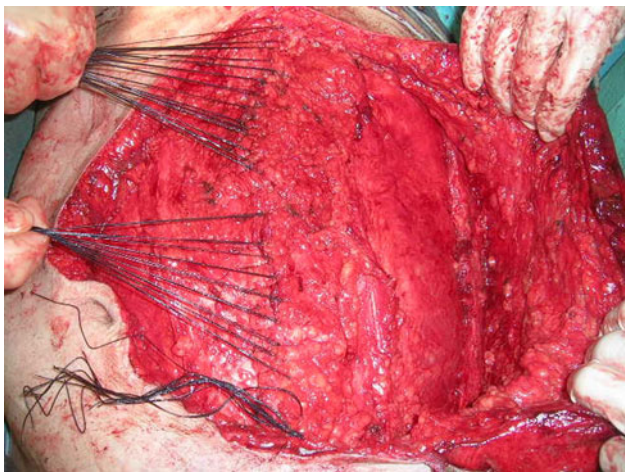

Fig. 1 Closure at midline with the components separation technique

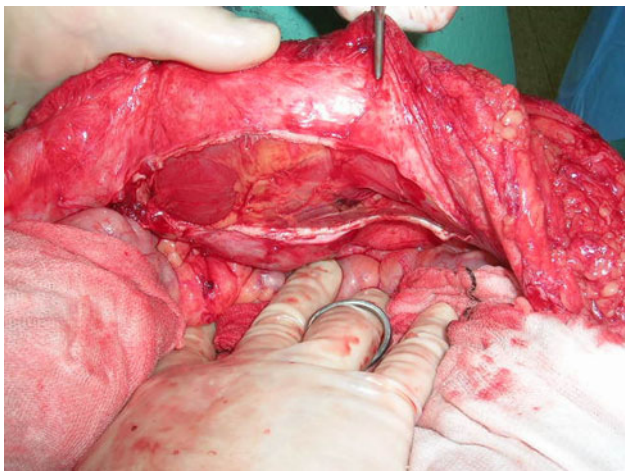

Fig. 2 Posterior rectus sheath incision (components separation technique)

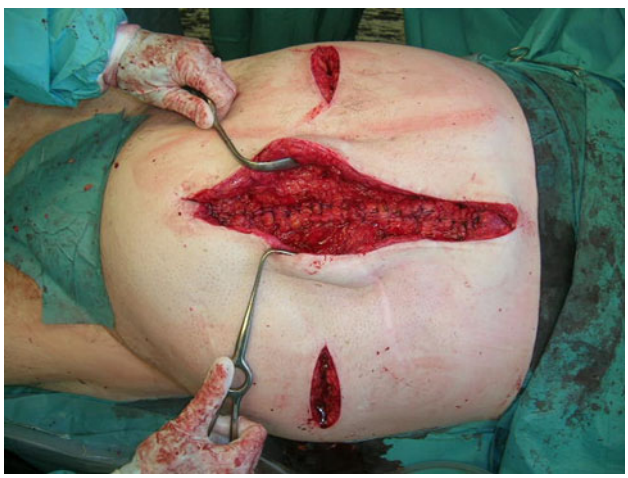

Fig. 3 Minimally invasive components separation

In a retrospective comparison of endoscopic and open component separation techniques in 44 patients, the two techniques had similar rates of recurrence (about 30%), but the endoscopy group had shorter lengths of stay and fewer major wound complications [6]. It is also noteworthy that the authors used mesh reinforcement in almost all cases (95% in the open surgery group and 100% in the endoscopy group) despite a contaminated field that was present in 91% of the open group and 73% in the endoscopy group, respectively. The biomaterials used included biological mesh (86 and 82%, respectively), permanent synthetic mesh (0 and 18%, respectively), and absorbable synthetic mesh (9 and 0%, respectively).

Mesh repair

Ventral hernia repair with an artificial mesh is a widely used method with a multitude of different mesh materials available. Comparison of the different meshes is beyond the scope of this review, and the biological meshes are described elsewhere in this issue of *World Journal of Surgery*. The important aspects of using mesh for late repair of extensive abdominal wall defects include the following: availability of normal skin to cover the mesh, applicability of the underside of the mesh directly over the bowel without causing bowel erosion with fistula formation or excessive adhesion formation (if intraperitoneal or inlay technique is used), and the risk of infection when used in a contaminated field (inadverted bowel lesion during mobilization, presence of enteric fistula, simultaneous enterostomy closure).

Microvascular flaps

Vascularized flaps provide healthy autologous tissue coverage without implantation of foreign material at the closure site. Pedicled flaps can be used in small and mid-sized defects in the arch of the rotation of the flap. Microvascular flaps are required if the defect is large or located in the upper abdomen or if pedicled options have already been used and offer an autologous, single-stage reconstructive solution. The tensor fasciae latae (TFL) myocutaneous free flap was first described in 1978 and since then about 100 cases have been reported [7–20]. The deep inferior epigastric vessels are most commonly used as recipient vessels, but intraperitoneal vessels such as the gastroepiploic vessels, allow the use of flaps with shorter pedicles and tight, continuous, circumferential fascial closure between the flap and native abdominal wall [14]. Another option is to use an arteriovenous (AV) loop constructed from the great saphenous vein [20, 21].

The technique used at our institution is a modification of previously published techniques [16, 17, 21]. The musculofasciocutaneous TFL flap (with a skin component measuring 30 to 35 cm × 15 to 20 cm and the underlying fascia with the tensor fasciae latae muscle) is harvested from the thigh and its pedicle dissected free toward the deep femoral artery and vein. In patients with large defects, the rectus femoris muscle can be included in the flap to ensure adequate perfusion of the distal tip. The ipsilateral great saphenous vein is divided distally above the knee, and its distal end is reflected proximally and anastomosed end-to-side to the common femoral artery, creating an AV loop (Fig. 4). The loop is tunneled subcutaneously to the edge of the defect and divided at its apex. Arterial and venous anastomoses with the flap vessels are performed with continuous 7-0 or 8-0 vascular sutures. The flap fascial edges are sutured to the fascial edges of the original defect, carefully avoiding any obstruction or kinking of the flap vessels. Drains are placed subcutaneously, and the subcutaneous space and skin are closed with interrupted sutures or staples. The donor site is closed directly as far as possible, and the remaining defect is covered with a split-thickness skin graft [20].

Compared with the anterolateral thigh flap, the anatomy of the TFL pedicle is constant; and it offers large-caliber vessels matching the vessel size of the great saphenous vein loop. Furthermore, the size of the flap can be quite large, up to 20 × 35 cm (Fig. 5). With very wide flaps, however, the relative thinness of the anteromedial portion of the fascia, especially in women, sometimes requires mesh enforcement. Functionally, the TFL flap is passive, resembling mesh. Ninkovic and coworkers described functional, dynamic reconstruction of a full-thickness abdominal wall defect with an innervated free latissimus dorsi musculocutaneous flap [22].

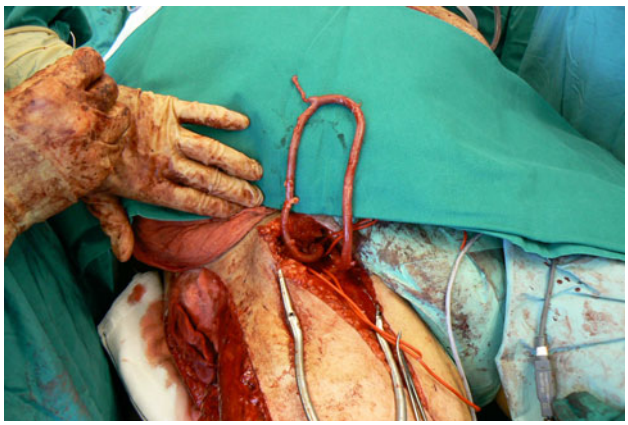

Fig. 4 Free tensor fasciae latae flap with arteriovenous loop

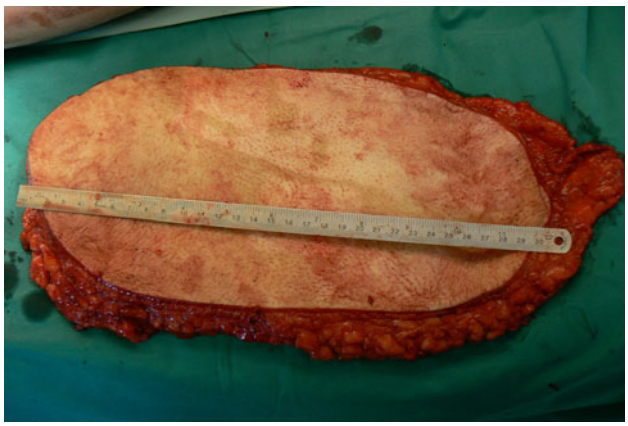

Fig. 5 Large tensor fasciae latae free flap

Which technique to use?

Most patients even with large abdominal wall defects can be treated with components separation or mesh repair alone provided the original skin can be closed over the repair (type I defects). The most important aspect of reconstructing a functional abdominal wall is re-creation of the linea alba and achieving midline closure, allowing the abdominal wall to be encompassed by functional muscular components in a manner similar to normal anatomy [6]. In contrast to inert material, the abdominal musculature provides dynamic support of innervated tissue to redistribute the stress applied from intraabdominal forces.

The use of mesh enforcement with the components separation technique is controversial. In a long-term follow-up study, the use of prosthetic enforcement increased the recurrence rate fourfold [23]. By using a modified technique where an additional relaxing incision of the internal oblique muscle is followed by suturing the medial border of the posterior sheath to the lateral border of the anterior sheath, the authors reduced the recurrence rate to 5% without using prosthetic mesh.

It seems that in type I defects with intact skin coverage either mesh or the component separation technique is a reasonable option. In a recent randomized, controlled study comparing the components separation technique to prosthetic repair with e-PTFE patch in 37 patients, reherniation rates were higher after components separation (10/19 vs. 4/18) [24]. Because of the high infection rate leading to removal of the prosthesis in seven of the 18 patients, however, the trial was discontinued at the interim analysis. Preliminary reports indicate that the use of biological mesh in a contaminated field is feasible, and they might provide an option in patients at high risk of infection and unsuitable for the components separation technique [25, 26].

Complex reconstruction techniques are required mainly in extensive defects without intact skin (type II defects) or when previous repair has failed, such as in patients with infected and exposed mesh. In a recent report of 20 patients undergoing a microvascular TFL flap repair, the perioperative mortality was zero, and there were no intraabdominal or deep surgical-site infections [20]. There was one flap failure, and two patients had minor distal tip necrosis requiring only revision and primary skin closure. During a follow-up period of 2 years (range 0.5–13.0) years, there was only one hernia recurrence 3 months after the TFL repair. Due to a large defect or a too-thin fascial component of the TFL flap, an additional components separation procedure was performed in one patient, mesh enforcement in nine patients, and a combination of the two techniques in one patient.

Table 1 Management options for abdominal wall defects

Defect	Primary procedure	Additional (+) or optional procedures
Small or midsize hernia, intact skin		
No contamination	CS	M
Contamination	CS	Mb
Small or midsize hernia, grafted skin		
No contamination	CS	+M or flap
Contamination	CS	+Mb or flap
Large hernia, intact skin		
No contamination	CS	+Flap or M
Contamination	CS	+Flap or Mb
Large hernia, grafted skin		
No contamination	Flap	+CS + M
Contamination	Flap	+CS + Mb

CS components separation, *M* mesh repair, *Mb* biological mesh

Based on the available literature, consisting mostly of retrospective studies, the choice of the most appropriate late abdominal wall reconstruction method after planned hernia strategy is summarized in Table 1. It should be noted, however, that the repair of complex abdominal wall defects requires a multispecialty approach and close collaboration with plastic and abdominal surgeons. The most complex cases are probably best treated in specialized centers [27].

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