Flaps for Reconstruction: Vertical Rectus Abdominis Myocutaneous Flap

18

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18.1 Introduction

Abdominoperineal extirpation (APE) especially for bulky tumours and above all in conjunction with previous radiotherapy is not infrequently followed by perineal wound complications, including intrapelvic abscess formation. According to the literature, delayed and persistent wound healing with recurrent pelvic sepsis can be observed in as many as 25–60% of patients. According to Paun et al. [1] and Milne et al. [2] this is related with complications reported in 40 (82%) patients, with major and minor complications in 19 (39%) and 38 (78%) patients, respectively. These complications may result from large, non-collapsing dead space with poor vascularity of the irradiated surrounding tissue or the use of irradiated skin in the closure. These problems are even more pronounced in far advanced pelvic malignancy or recurrent tumours necessitating extralevator abdominoperineal (APE) excision. The incidence of wound complications is even higher after extralevator APE [3]. To accomplish this, complete or partial removal of all of the pelvic viscera, vessels, muscles, ligaments and part of the pelvic bones may be necessary. As a result, pelvic exenteration is often associated with significant morbidity and even mortality, which may result also from inadequate closure of tissue defects.

Over the past decade it has been shown that flap reconstruction for the large pelvic/perineal defects created by resection results in lower wound-complication rates than do primary closure methods, if the latter are feasible at all. In particular the transfer of the pedicled vertical rectus abdominis myocutaneous (VRAM) flap significantly reduces common complications by obliterating pelvic dead space and by recruiting healthy, well-vascularised tissue into the pelvic region, which has been irradiated and is often contaminated by various germs [4, 5].

Commonly used flaps for perineal reconstruction include the gracilis myocutaneous [6, 7], pudendal, perforator based flaps [8, 9], the greater omentum, anterolateral [10] or posterior thigh [11], vertical rectus abdominis myocutaneous (VRAM) flaps [5, 12–15] and in certain circumstances free muscle flaps [16, 17]. VRAM flaps generally have greater bulk and a more reliable vascular supply to the skin paddle than thigh-based flaps. In one study, local wound complications after salvage were 60% after no reconstruction, 60% after reconstruction with gracilis muscle, 100% after omentoplasty and 25% when using a VRAM [18]. One major advantage of the VRAM flap is that the rare but hard-to-treat problem of pelvic bowel herniation can be safely prevented by filling the lower pelvic space with the rectus muscle [13, 19].

18.2 Preoperative Considerations and Measures

Usually the right-sided rectus abdominis muscle is considered as first choice and is more often used due to the necessity of a left-sided colostomy in case of abdominoperineal extirpation [13]. In patients with previous right- and left-sided colostomies as well as in cases with previous transverse laparotomies, computerised tomographic angiography is strongly recommended in order to assess patency of the epigastric axis from its origin up to the xyphoid. Under these circumstances, safe harvest of a VRAM flap can be performed only upon confirmation of patent vascular axis on the

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side chosen. Preoperative marking of the planned skin paddle and location of the colostomy is performed routinely on the day before surgery (Fig. 18.1).

Caution is paid to the prospective shift of the abdominal skin on the left side after harvest of the VRAM and the slight shifting of the abdominal skin at final wound closure to ensure that the colostomy will not be distorted. We plan the colostomy marking 2 cm more laterally than usual to ensure later proper position of the stoma.

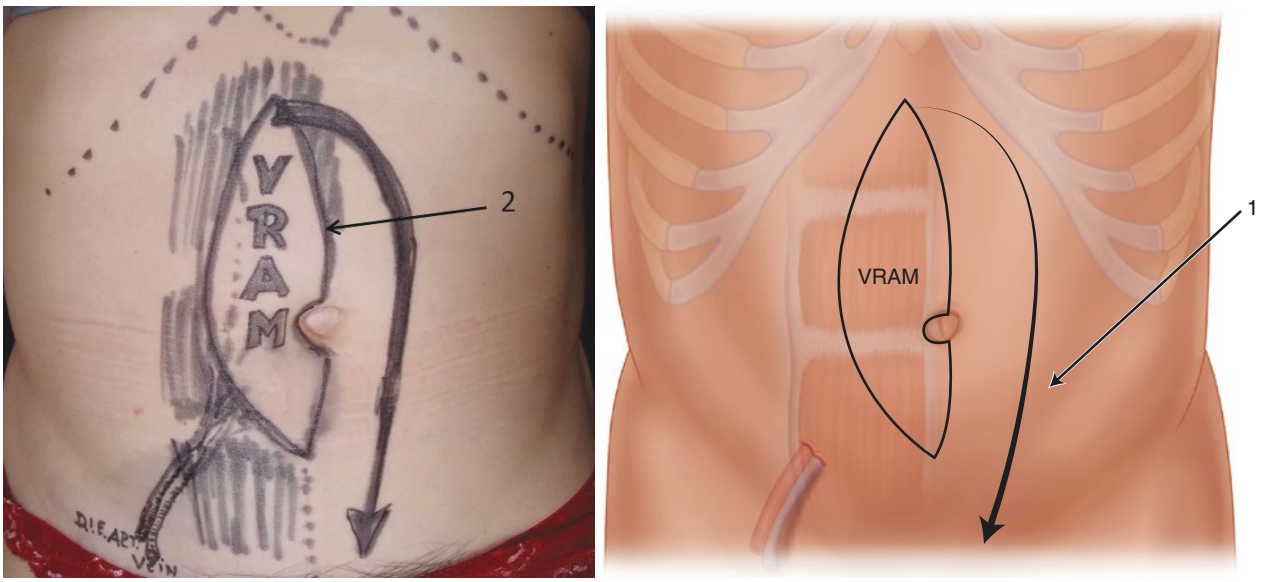
The design of the skin paddle is planned according to the prospective perineal and/or pelvic defect or the part of the vagina to be reconstructed, respectively. These measures are determined by the skin area to be excised in the perineal and/or perianal region, as well as possible intrapelvic demands for filling intrapelvic dead space or to cover structures such as the urinary bladder or ureter that may need well vascularised muscular coverage. The skin paddle should be tailored to the extent of skin (with the underlying subcutaneous tissue

Figure 18.1

Preoperative skin marking prior to VRAM-flap harvest. The site of the stoma (1) still to be marked. The midline incision turns around the right side of the umbilicus (2). The midline incision will be advanced from the lower edge of the skin spindle to the symphysis for laparotomy. Arrow indicates prospective route of VRAM flap movement into pelvis

and anterior rectus sheath) that is needed for the reconstruction in order to facilitate a tension-free closure of the abdominal skin. However, a minimum width of 5–6 cm, depending on the thickness of the subcutaneous abdominal tissue (i.e., the thicker it is, the broader the skin island should be designed), has to be harvested. This is necessary to include a sufficient number of randomly distributed perforators arising from the inferior epigastric artery, which provide the blood supply to the overlying abdominal subcutaneous fat and skin territory. Designing a skin island that is too narrow may inevitably result in a vessel depleted and an unperfused skin island.

Figure 18.1



Even if no major skin defect results from the abdominoperineal excision, the elevation of a significant skin paddle (with its underlying fat) often becomes necessary in order to gain a sufficient volume of tissue to fill the pelvic dead space and to allow suturing to the pelvic structures. In those cases the complete skin paddle is de-epithelialised and buried within the pelvic cavity. Using instead a rectus abdominis muscle flap without a skin paddle usually results in a flat muscle flap with no bulge to fill the pelvic cavity. Furthermore, the formerly cranial tip of the "muscle-only-flap" needs to be attached as deep in the pelvic cavity as possible to prevent the flap from early retraction and shrinkage, which can be circumvented successfully if a significant skin paddle attached to and raised with the muscle is applied.

The skin paddle of the VRAM flap, which is harvested in a longitudinal fashion, can also be split transversely but only in the skin and subcutaneous tissue levels, to give free mobility for the distal part to adequately reconstruct the posterior vagina during the same operation. Usually this manoeuvre is not necessary for reconstruction of a single perineal skin defect, as in cases of rectal extirpation. Furthermore, the flap can be split either longitudinally to produce tongue flaps or in a horizontal fashion, so that complex vulvoperineal wounds can be covered or the vulva can be resurfaced. This manoeuvre can provide an edge to reattach the vaginal cuff and recreate the fourchette [19, 20]. Di Benedetto et al. [21] have also reported perineal reconstruction with a sensate VRAM flap through end-to-end nerve anastomosis between the cutaneous ramus of the eighth intercostal nerve and the superior branch of the pudendal nerve to achieve sensibility.

In Erlangen, the patient's position is usually changed, starting with the patient in a supine position for the oncological operation, followed by the harvest of the VRAM flap, which is then wrapped into a protective sterile plastic bag and temporarily positioned in the pelvis. This step is followed by abdominal closure and placement of the stoma; then the patient is turned to the prone position for the second part of the operation. After the oncological part is completed, the VRAM flap is pulled through the pelvis and finally inserted depending on the individual need of reconstruction

Figure 18.2

Deep inferior epigastric vessels (1) are dissected lateral to the lower third of the rectus muscle prior to raising the flap

(Fig. 18.2). Due to the change from supine to prone position some of the steps, such as abdominal closure and stoma formation, cannot be performed simultaneously and will therefore extend surgical time [13]. Given the distinct advantage of the combined primary reconstruction in terms of quality of life and avoidance of complications, this additional operating time seems acceptable.

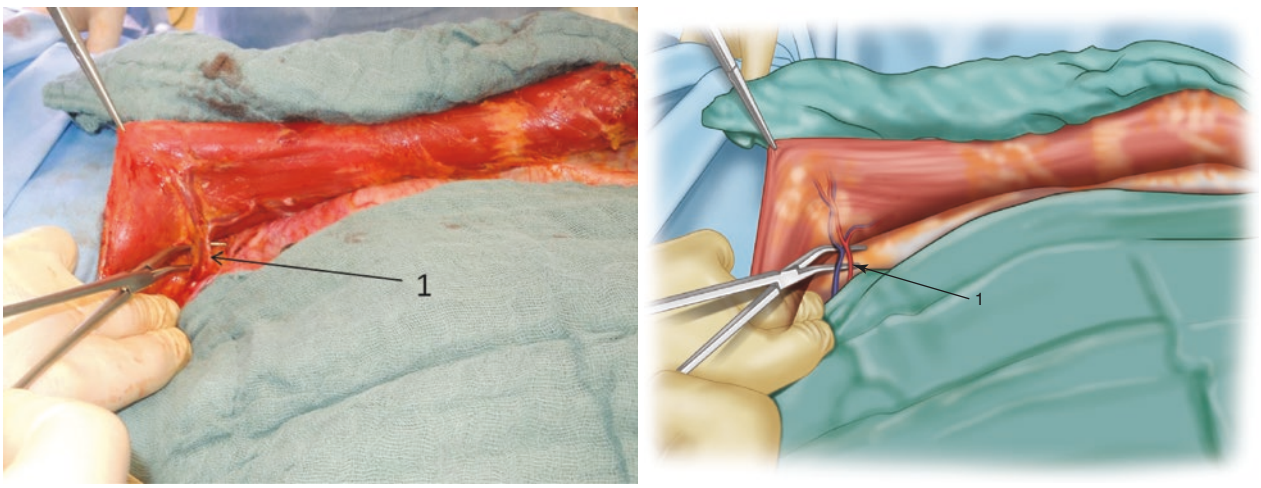
18.3 Operative Procedure

After laparotomy, a suprapubic percutaneous bladder catheter is placed through a paramedian approach. It is important to use the contralateral side to the planned VRAM flap for this catheter insertion, to avoid injuries to the epigastric vessels, supplying the flap.

First, the oncologic intraabdominal part of the operation is completed before the flap is dissected. When starting to harvest the flap, one may ensure the existence and patency of the deep inferior epigastric vessels before proceeding to raise the flap. Therefore, the rectus sheath is opened caudally by an anterior incision in the linea alba. Then the anterior sheath is mobilised from the underlying muscle belly, proceeding from medial to lateral. Finally the lateral edge of the rectus abdominis muscle is elevated and the underlying lateral fat is dissected until the deep inferior epigastric artery and vein are visualised before entering the muscle from beneath (see Fig. 18.2). Thus by visual and palpatory assessment of vessel pulsatility, the patency of deep inferior epigastric vessels can be ensured prior to proceeding with raising the flap. If in doubt, such as after multiple previous abdominal operations, additional evaluation using a sterile handheld Doppler probe can be helpful.

If a skin island is used, as in almost any case in our series, it is commonly tailored directly over the superior part of the rectus muscle in a vertical orientation, hence, the abbreviated term VRAM-flap (vertical rectus abdominis myocutaneous flap). It is incised using a scalpel and the subcutaneous tissue is mobilised using monopolar diathermy directly down to the anterior rectus sheath, which is

Figure 18.2



to be preserved. Then by epifascial mobilisation of the fat from both sides the lateral and medial rows of epigastric artery perforators are reached. The width of the anterior sheath to be incised can be minimised as much as possible. Thus, donor site morbidity concerning the fascial defect can be limited such that direct fascial closure can be achieved. However, according to several studies and our own experience regarding abdominal wall closure after VRAM-flap procedures, it is generally recommended to use a nonresorbable inlay-mesh implantation to support abdominal-wall stability and prevent development of bulging or even an incisional hernia [13, 22, 23].

Figure 18.3

The cranial origin of the rectus muscle (1) will be detached from the costal margin during VRAM-flap elevation followed by ligation of the dissected superior epigastric vessels (2)

Figure 18.4

The rectus abdominis muscle together with the skin island is then reflected and the lateral subcostal neuro vascular bundles (1) are dissected and ligated

The rectus muscle (with the skin paddle and the supraumbilical medial part of the anterior rectus sheath attached) is raised leaving the posterior rectus sheath and the infraumbilical anterior rectus sheath intact. Special care is given to haemostasis and to surgical dissection in the areas of segmentation of the rectus muscle to avoid injury to the blood supply. The rectus muscle is disconnected cranially from the rib cage using monopolar diathermy. The superior epigastric vessels are divided after ligation with 3/0 vicryl sutures (Fig. 18.3) [13] and the lateral intercostal and subcostal nerves and supplying vessels are dissected and ligated (Fig. 18.4).

Figure 18.3

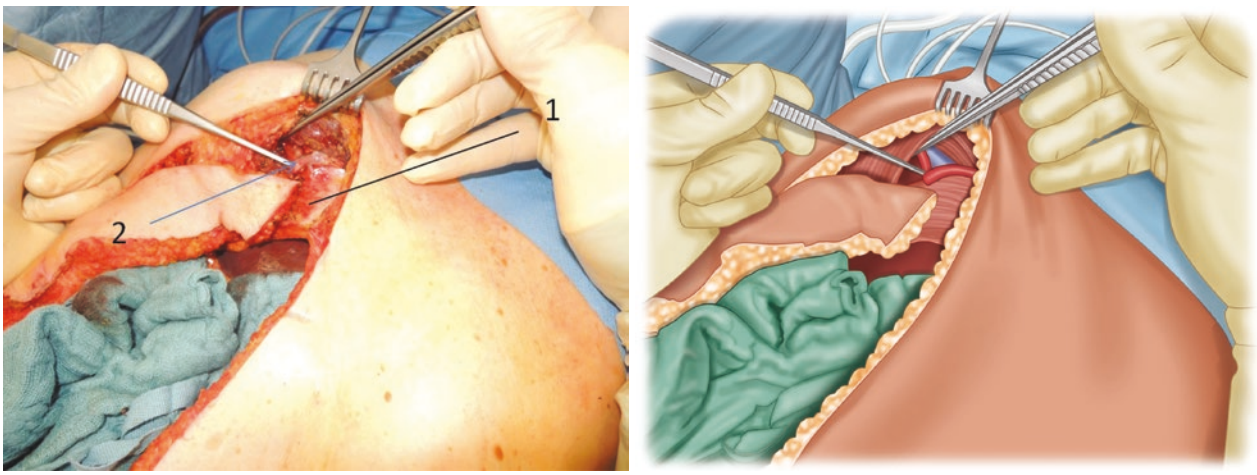
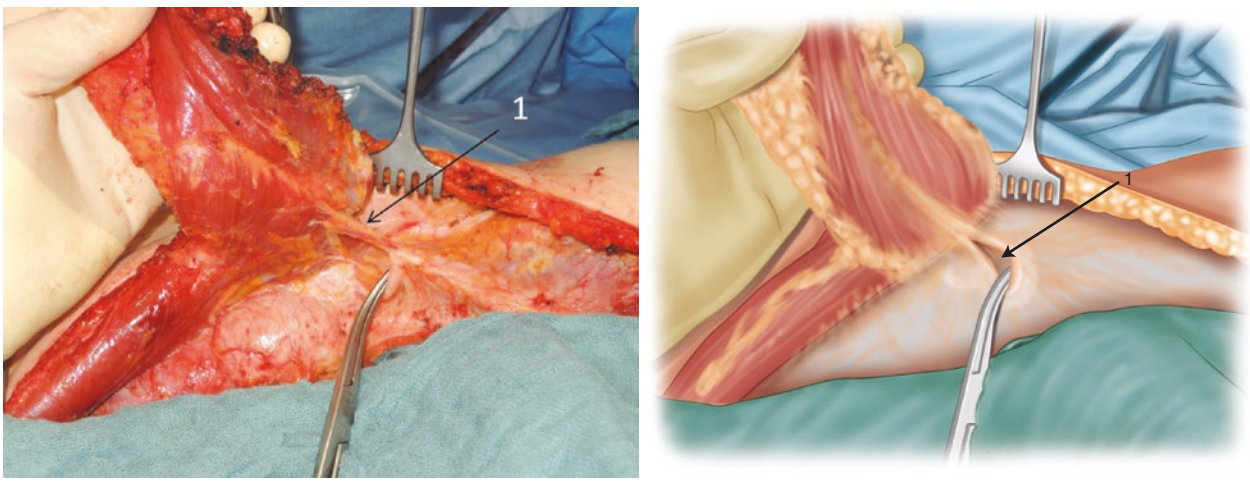


Figure 18.4



The inferior epigastric vessels which were visualised earlier are now dissected down to their origin from the external iliac vessels. Usually detachment of the caudal rectus abdominis muscle insertion at the pubic bone is not necessary. However, if further increase of the arc of rotation is needed, this can be achieved by cutting the pubic attachment of the rectus muscle using monopolar diathermy. Care is given to leave at least the pyramidal component of the rectus insertion attached to prevent stress to the vascular pedicle when the flap is moved through the pelvis (Fig. 18.5) [13].

Figure 18.5

The caudal rectus muscle insertion can laterally be dissected from the pubic bone (1), while the (medial) pyramidalis part of the muscle (2) should be left in situ and remains attached to the pubic bone to prevent strain on the pedicle vessels

Figure 18.6

Posterior aspect of the undersurface of flap completely raised with pedicle vessels (1) intact and visualised, immediately before temporary pelvic placement and prior to later pull-through procedure

The completely raised flap (Fig. 18.6) is then flipped and rotated 180 degrees around the horizontal axis (turn over procedure) and placed transiently into the pelvic cavity protected in a plastic bag. In principle, the flap can be transposed in two ways during its path through the pelvis: the flap is either twisted around its horizontal axis only, allowing the previously cranial/xyphoidal tip of the flap to be attached to the anterior/pubic edge of the defect and the previously caudal tip of the skin paddle to be orientated towards the posterior/sacral part of the defect (Fig. 18.7). Alternatively, the

Figure 18.5

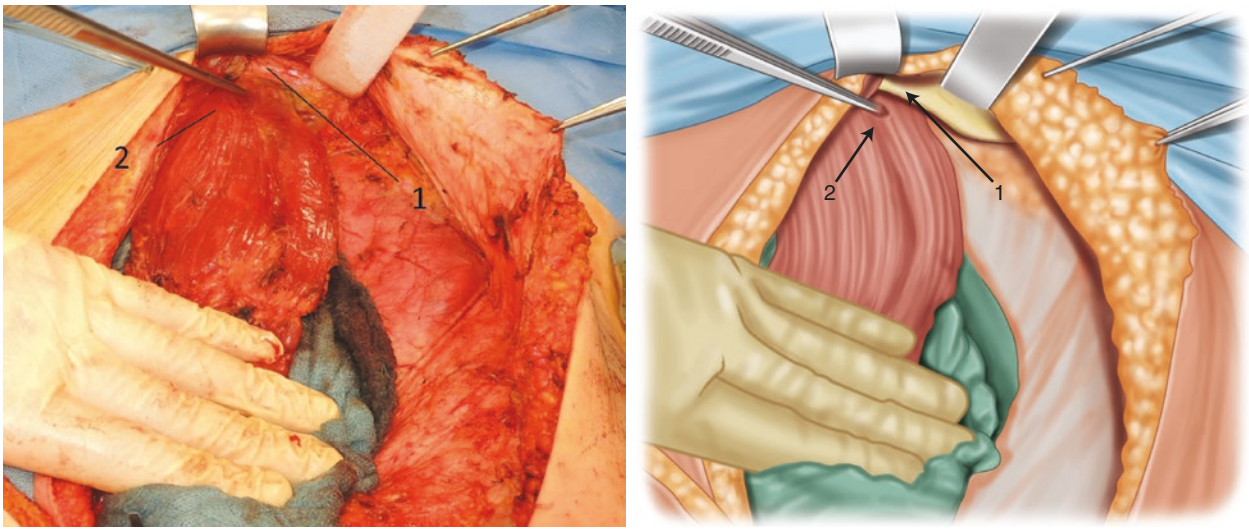
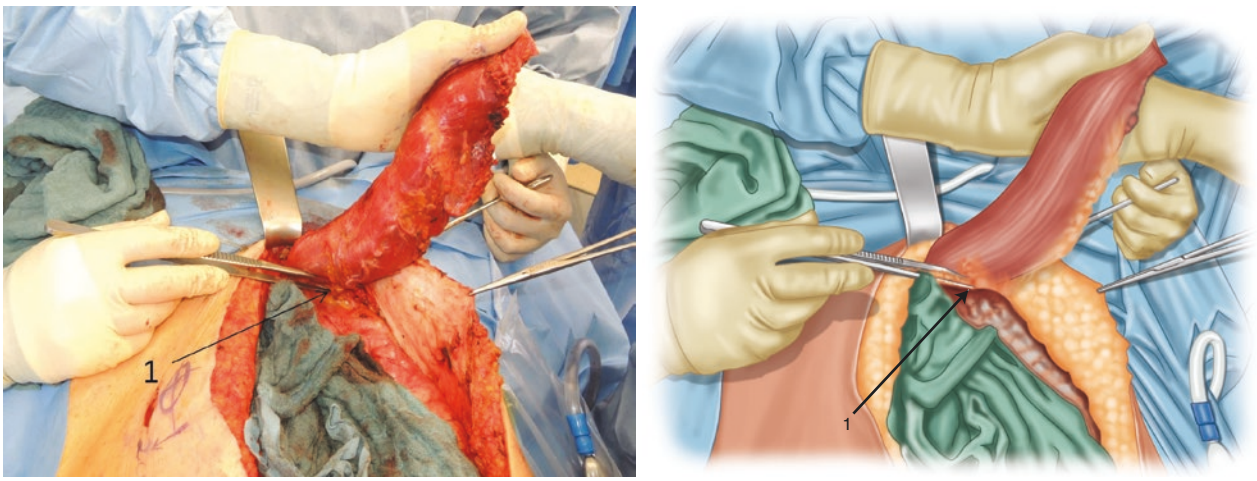


Figure 18.6



flap is additionally twisted along its longitudinal axis, allowing the previously cranial part of the skin paddle to reach the sacral end of the defect and the former caudal tip of the skin paddle to face the anterior border of the defect [5, 24].

The latter rotational transposition may require a larger arc of rotation, while the first approach circumvents a "double-twist" to the flap and thus to the pedicle vessels. From our experience, therefore, this technique should be used preferably whenever possible [13].

Abdominal wall closure is performed either simultaneously with perineal flap insertion if the patient remains in lithotomy position throughout the whole operation (as is commonly done, for example, in anterior pelvic exenteration) or after the flap is temporarily banked within the pelvic

Figure 18.7

Horizontal twist (only), which means that the previously xyphoidal tip (1) of the flap is finally oriented towards the lower end of the sacrum (the coccyx is usually resected), anteriorly

Figure 18.8

Peritoneal closure and simple suture closure of posterior abdominal fascia (1) and wall. The superior muscle donor site is reinforced with a sublay-mesh behind (not visible) to prevent bulging or hernia formation during fascial repair. The lower part of the arcuate line (2) that demarcates the lower limit of the posterior layer of the rectus sheath is not harmed during flap harvest and can be closed primarily

cavity, before turning the patient to the prone position (as for most rectal excisions in personal practice) (Fig. 18.8).

A potential downside of VRAM flaps versus flaps from other areas of the body is a potential weakening of the abdominal wall after the rectus muscle harvest. However, by using, for example, a double vicryl-prolene mesh to close the defect in the supraumbilical anterior rectus sheath—even when direct suture seems easily feasible—hernia and bulging complications are only rarely seen. Others have shown a similar rate of incisional hernia after VRAM flap surgery [25] which is within the worldwide range of reported post-laparotomy incisional hernias (2–11%). However, these rates need to be compared with figures from a large cohort study registry of 28,913 cases on the incidence of

Figure 18.7

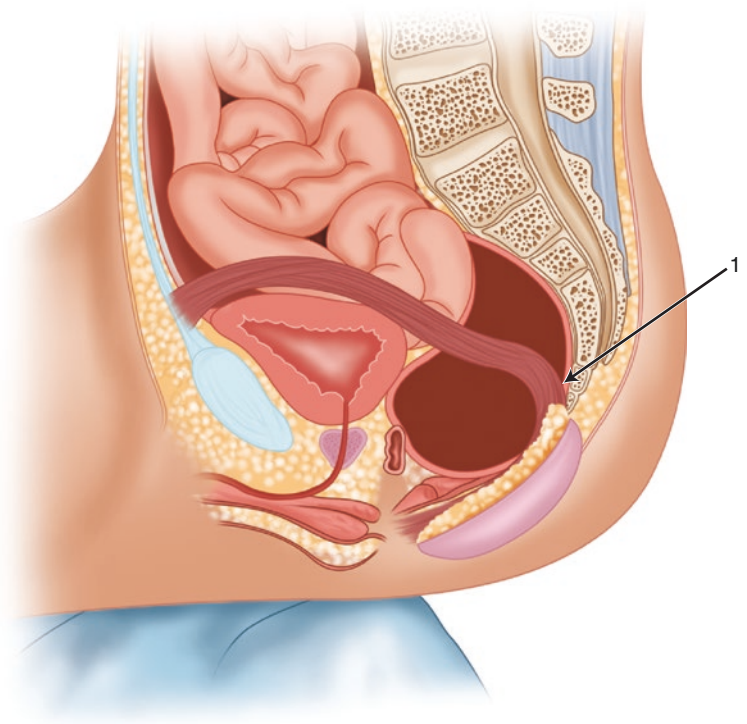
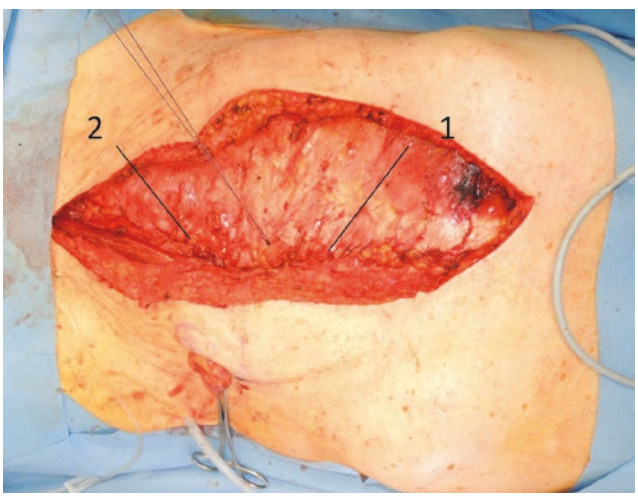
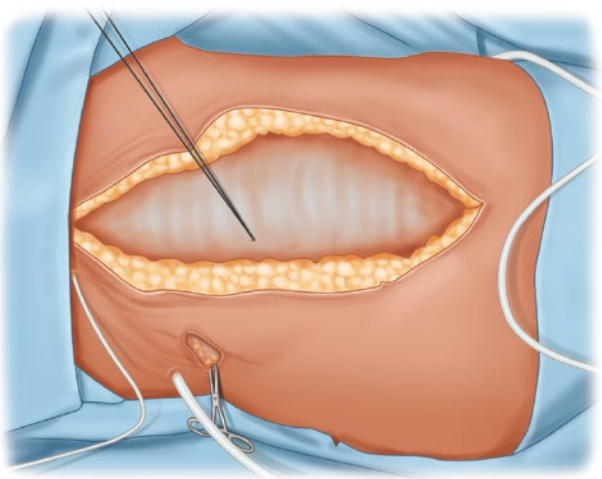


Figure 18.8





incisional hernia and risk factors for developing incisional hernia following surgery for colorectal cancer, where the cumulative incidence of incisional hernia was 5.3% at 5 years after surgery [26].

After completion of the perineal part of the oncological resection, with the patient in the prone position, the flap in the plastic bag that has been attached to the rectal stump can be visualised and harvested from its temporary position within the pelvis, whence it can then be pulled through completely (Fig. 18.9). Before definitely inserting the flap, two large calibre passive silastic drains are usually placed within the pelvic cavity and led out through the gluteal area to allow

Figure 18.9

VRAM flap pulled through immediately prior to securing the flap (one of the 2 intrapelvic silastic drains visible in the background) (patient in a prone position; 1 = caudal tip of the abdominal skin spindle)

Figure 18.10

55-Year-old female patient in a prone position needing abdominoperineal rectal extirpation, posterior vaginal wall resection due to squamous cell carcinoma of the anus having had previous radiotherapy. Reconstruction of the posterior vaginal wall with part of the VRAM flap during the same procedure (1 = sacrum, 2 = cranial end of VRAM flap, 3 = vaginal reconstruction)

for evacuation of seroma and haematoma from the deepest point of the pelvis (see Fig. 18.9). Finally, the skin island can be partially or completely de-epithelialised if necessary in order to obtain adequate closure of the perineal defect or to adapt the flap island size to that required. In case of partial vaginal resection, part of the vaginal tube can be reconstructed using the skin paddle of the VRAM flap. In these cases, the remaining part of the skin paddle is usually de-epithelialised (Fig. 18.10). If there is an additional skin defect more posteriorly with an intact bridge of non-resected perineal skin in between, two parts of the skin are inserted (the caudal third for vaginal posterior wall reconstruction,

Figure 18.9

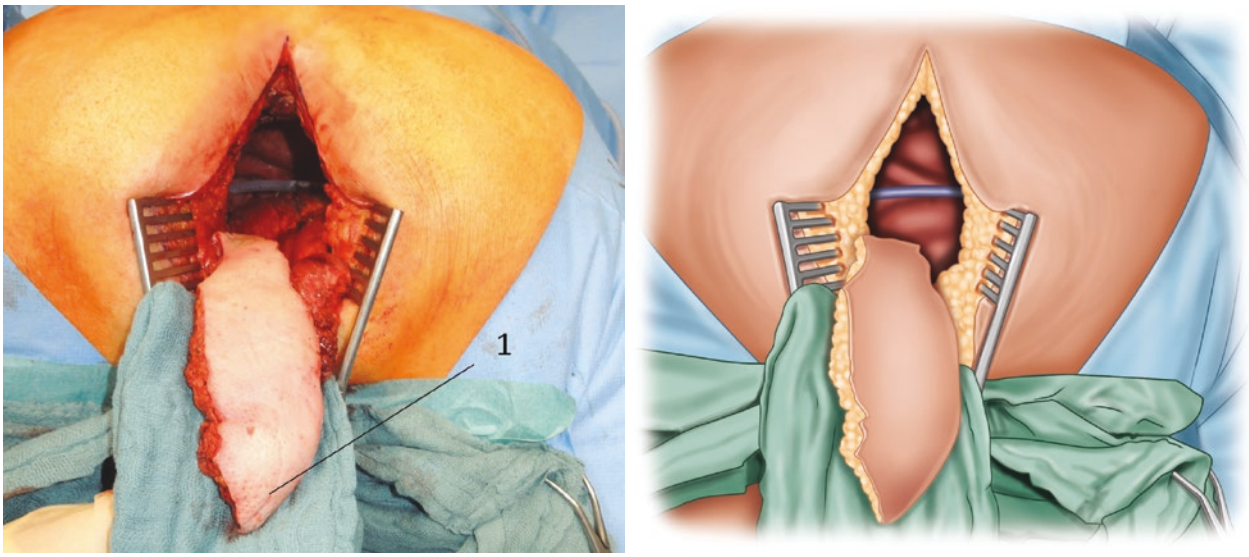
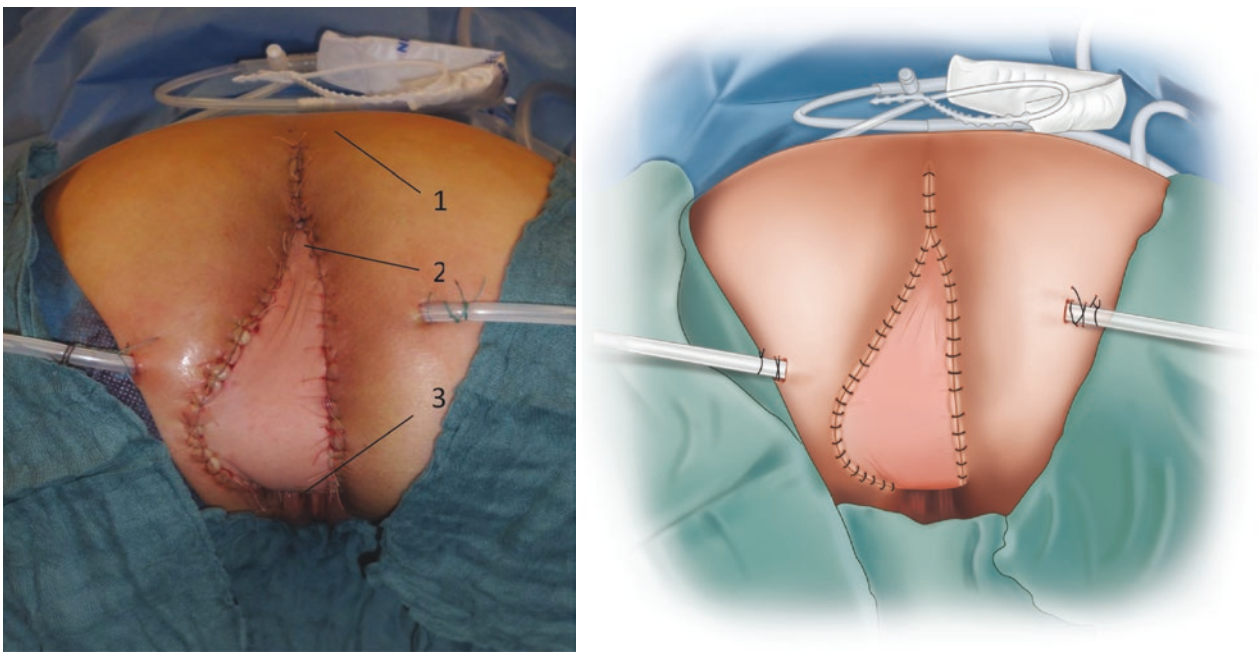


Figure 18.10



the cranial third for the posterior/perianal defect), while the central part of the skin paddle is de-epithelialised lying behind the intact perineal skin.

Chronic pelvic sepsis, not infrequently life-threatening after extended abdominoperineal rectal extirpations, in particular in combination with previous radiotherapy, can almost never be solved without the use of flaps.

These conditions are extremely difficult to handle, since a secondary transpelvic VRAM flap is often impossible due to extreme intraabdominal adhesions or a narrowed small pelvis. Therefore only strategies to bring well-vascularised tissues into the pelvic cavity without having to go through the abdominal cavity again are suitable: among these, a number of local pedicled flaps have been described, e.g., the gluteal myocutaneous flap or the proximally pedicled gracilis flap [16]. However, most of these flaps fail to reach far enough into the pelvic or presacral cavity to completely fill this anatomical dead space. Therefore, the most potent solution for these very challenging patients is a microsurgical free flap transfer. By these means the entire flap volume can be put into place much more independently from the anatomy of its pedicle compared with any local flap. However, a common

Figure 18.11

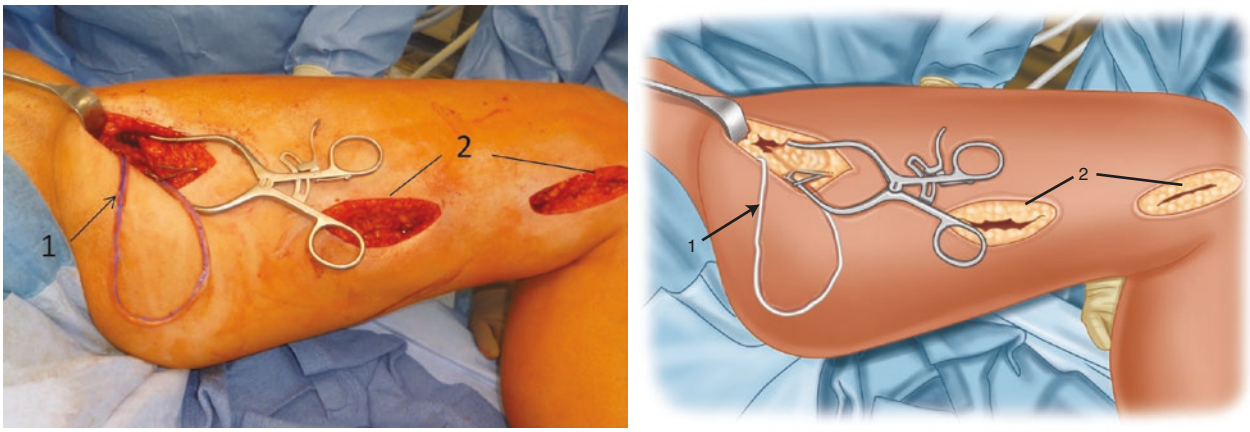
Two weeks prior to a free microvascular flap, an arterio-venous saphenous vein loop (1) is created (2 = incisions to harvest the saphenous vein)

Figure 18.12

44-Year-old patient with previous multiple abdominal operations due to rectal cancer presenting with a sinus from non-obliterating presacral cavity with chronic fistulation and recurrent pelvic infections. After debridement as a first step and interim vacuum application, reconstruction with a free microvascular transplantation of a myocutaneous latissimus dorsi flap (1) 7 days after AV loop procedure (2 = saphenous vein as a loop, 3 = anastomosis to the thoracodorsal artery)

additional obstacle is a lack of local recipient vessels, since the adjacent vessels are either too small (e.g., the inferior gluteal artery and vein), or too far away (e.g., the femoral artery and vein). In these complex cases, the free muscle flap transplantation connected to an arteriovenous vessel loop may be an option. In our experience a combined approach together with the vascular surgeon should be performed in a first operation 1–2 weeks before a free microvascular flap is then performed with vascular connection to this AV loop; an arteriovenous loop (AV-loop) is created by connecting a venous graft (usually the grafted saphenous vein) to the femoral artery and vein as an AV-loop (Fig. 18.11). The loop runs from the groin through the groin crease towards the perineal region and back, with its apex lying as close to the cavity opening as possible. In a second operation, a free myocutaneous flap (e.g. latissimus dorsi flap) is transplanted 7–14 days later (Fig. 18.12). With this complex two-stage procedure providing a safe solution, these otherwise hard-to-treat conditions can be offered, at least in microsurgical high-volume centres, to these challenging patients.

Figure 18.11



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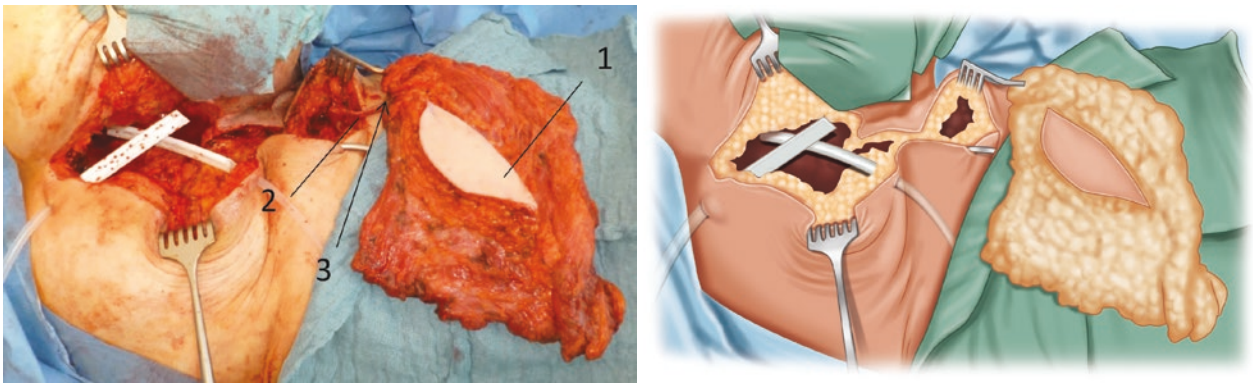

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