ORIGINAL PAPER

Abdominal, perineal, and genital soft tissue reconstruction with pedicled anterolateral thigh perforator flaps

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Abstract

Background Pedicled perforator flaps have become a contemporary alternative to muscle flaps for soft tissue reconstruction as they have reduced donor site morbidity, avoid the need for microsurgical transfer, and are versatile and reliable. The anterolateral thigh (ALT) flap was first introduced as a free flap and has since gained popularity as a pedicled flap. Here we review our experience using pedicled ALT flaps for regional soft tissue reconstruction.
Methods We retrospectively reviewed all patients who underwent loco-regional soft tissue reconstruction using pedicled ALT flaps between March 2014 and October 2018, with the goal of identifying potential applications of pedicled ALT flaps. The following aspects of each case were reviewed: patient demographics, defect location and size, comorbidities such as previous radiotherapy, flap details, clinical follow-up, and postoperative complications.
Results Our analysis demonstrates the versatility of pedicled ALT flaps in a variety of indications to successfully cover large abdominal, perineal, and genital soft tissue defects. Depending on the patient's needs to achieve more bulk or stability in the reconstruction, the ALT flap was individually tailored with underlying muscle or fascia. The average follow-up was 7 months (range: 3–13 months).
Conclusions Pedicled ALT flaps are a valuable reconstructive option for soft tissue defects located within the pedicle's range, from the lower abdomen to the perianal region. These flaps are usually raised from a non-irradiated donor site and are sufficient for covering extensive soft tissue defects. Three-dimensional reconstruction of the defect using pedicled ALT flaps allows for anatomical function and minor donor sites.
Level of evidence: Level IV, therapeutic study.

Keywords ALT flap · Anal carcinoma · Defect · Resarcoma reconstruction · Vulva reconstruction

Introduction

Defects of the perineum, lower abdominal wall, and genital zone comprise a demanding field in reconstructive surgery. Extensive defects in these regions, which can result from tumor resections, infections, or trauma, require adequate coverage because of their complex layers and protection of vital organs. A reliable reconstructive plan is needed to account potential dehiscence or fecal contamination, as well as pressure on the area of reconstruction when sitting or

lying [1]. Due to its reliability, the option of harvesting multiple tissue components, proximity to the defect, and minor donor site morbidity, the anterolateral thigh (ALT) flap [2] has become a promising alternative to previously used flaps, such as the groin, tensor fasciae latae, sartorius, or gracilis myocutaneous flaps [3] or free flaps.

Song et al. first described the ALT flap in 1984 [3]. The ALT flap initially gained popularity as a free flap in head and neck reconstructions and, following the subsequent introduction of pedicled perforator flaps, has since revolutionized reconstructive microsurgery [4]. The pedicled ALT flap is currently used for soft tissue reconstructions ranging from the abdominal wall to the knee [5]. It was first discovered in Asia where it is still used on a large scale today. Conclusions can be drawn from Asian posture and body mass index on flap thickness [6]. Ethnic differences such as hairless skin of the thigh characterize Asian individuals [7] and have

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contributed to ALT flap's establishment as a reliable flap in Asian medical practice. However, this has not prohibited the ALT flap becoming a workhorse for various indications also in other ethnicities around the world.

In this case series, we report our indications over the last 5 years using the pedicled ALT flap for loco-regional soft tissue reconstruction in our hospital. We review the existing literature on similar applications of the pedicled ALT flap.

Materials and methods

Data were collected from all patients who underwent ALT flap surgery at the University Hospital of Zurich between March 2014 and October 2018. Patients who underwent free flap transfer and/or had recipient sites outside the abdominal, perineal, or genital regions were subsequently excluded. This study was performed in accordance with the Cantonal Ethics Committee of Zurich (BASEC-ID Nr.: 2019–00,151). Written informed consent was obtained from all patients. One patient decided not to participate and was excluded from this study, leaving 15 patients available for analysis.

We reviewed the applications of pedicled ALT flaps for loco-regional soft tissue reconstruction in each of these cases. For each case, we recorded the patient's age and sex, the cause of the soft tissue defect, the size and composition of the flap, and any observations from the follow-up visit. This information was obtained from referral letters, surgical reports, consultation reports, hospital discharge letters, outpatient clinic follow-up, and photo documentation from the hospital's computerized database. Patient morbidity was determined by the treating anesthesiologist using the American Society of Anesthesia (ASA) classification, and postoperative surgical complications were grouped according to the Clavien-Dindo classification [8]. The patients' demographic data, the cause of the defect, the reconstructive technique, and details about flap parameters are presented in the "Results" section, followed by illustrations of three representative cases from our series.

Surgical technique

The cases reviewed in this study were non-consecutive, and the decision to use a pedicled ALT flap was made independently in each case. The locations of the perforators were identified preoperatively using a hand-held Doppler. In some cases, computed tomographic angiography was used to analyze the size and course of the perforators. The ALT flap's arterial blood supply comes from the descending branch of the lateral femoral circumflex artery, which arises from the profunda femoral trunk [9]. The perforator and flap margins were outlined on the middle third of the axis of the anterior superior iliac spine and lateral patella. Flap elevation was

performed in the standard fashion in all cases, beginning with the identification of the pedicle through a medial subfascial incision [10]. The dissection continued laterally on a subfascial plane until the corresponding perforators had been identified. The lateral border of the flap was then elevated towards the septum and the perforator was skeletonized to the required length. To provide additional length, the flaps were tunneled under the rectus femoris and sartorius muscles. In oncological patients, tumor resection was performed by the primary treating physician prior or simultaneously and tissue reconstruction was subsequently performed by the plastic surgeon. In cases where extra bulk was needed to fill dead space, the pedicled ALT flap was harvested as a chimeric flap together with an adequate portion of vastus lateralis muscle. Primary closure of the donor site was performed in all cases in layers.

Results

Nineteen pedicled ALT flaps were performed on 15 patients during the study period at the University Hospital of Zurich to reconstruct soft tissue defects involving the abdominal, perineal, and genital regions. Eight patients were male (nine flaps) and seven were female (ten flaps), with an average age of 66 years (median: 69, range: 46 to 74, SD: ± 6.8). Summaries of the patients, as well as their defect and flap characteristics, are shown in Table 1. The most common indication for using a pedicled ATL flap was for reconstruction after oncologic resection ($n = 13$), followed by reconstruction following surgical debridement of Fournier gangrene ($n = 2$). The average follow-up period was 7 months ranging from 3 to 13 months (SD: ± 2.7 months).

Eleven of the 19 ALT flaps were fasciocutaneous and eight were musculocutaneous. One ALT flap was combined with a contralateral gracilis flap, one with a sartorius flap and one with a portion of the vastus lateralis muscle. These combinations were used to provide extra volume to obliterate dead space. Bilateral ALT flaps were used in four patients to reconstruct extensive soft tissue defects. Flap sizes ranged from 16×6 to 30×20 cm. No gross anatomical variations were encountered and no technical problems were experienced intraoperatively in any of the cases. All patients had significant medical comorbidities, with ten patients having more than three severe comorbidities. According to the ASA classification, there were six patients with a score of II, six with a score of III, and three with a score of IV.

We grouped postoperative complications according to the Clavien-Dindo classification [8]. Seven cases only required antibiotic treatment or a blood transfusion and were therefore allocated to grade II or lower. There were no reported complications above grade IIIb. All the flap procedures were performed successfully, except for one

Table 1 Patients' information

Patient/gender	Age	Cause and location of defect	Flap characteristics and size (cm)	Complications (Clavien-Dindo)/follow-up duration	Comorbidities/ASA score
1/F	71	Resection of an anorectal squamous cell carcinoma (perineal)	Ipsilateral myocutaneous ALT (16×6)	0/ 6 M	AHT, C, MN, RT, SIp, UI/III
2/F	74	Resection of a vaginal squamous cell carcinoma (genital)	Ipsilateral fasciocutaneous ALT (20×6)	0/3 M	C, HT, SIp, UI, 20 py/II
3/F	68	Resection of a vaginal squamous cell carcinoma (perineal)	Ipsilateral fasciocutaneous ALT (20×6)	IIIb (lymphedema)/6 M	BMI, C, C2, DM, MN, RT, SIp, UI, 50py/III
4/M	46	Resection of a myxoid liposarcoma (abdominoperineal)	Left myocutaneous ALT (n/a)	IIIb (wound dehiscence donor area)/6 M	BMI, C2, RT, SIp, 20 py/III
5/M	69	Persistent vesicorectal fistula in rectal carcinoma (perineal)	Left gracilis and right myocutaneous ALT (n/a)	I (partial intraOP skin necrosis/loss)/13 M	C, RT, SIp, UI, WI/III
6/M	74	Resection of a liposarcoma relapse (perineal)	Ipsilateral fasciocutaneous ALT (7×12)	IIIb (flap loss)/6 M	C, RT/III
7/F	57	Resection of vaginal clear cell adenocarcinoma (genital)	Bilateral myocutaneous ALT (n/a)	IIIb (related to free fibula transplant)/11 M	C, MN/II
8/F	74	Resection of a colorectal adenocarcinoma (abdominal)	Right fasciocutaneous ALT (28×8)	II (seroma)/6 M	C, DCM/II
9/F	62	Resection of a vaginal squamous cell carcinoma (genitoabdominoperineal)	Bilateral fasciocutaneous ALT (30×20)	IIIb (4 months postOP right groin repair after seroma and wound dehiscence)/6 M	AHT, BMI, C, RT, UI, 20 py/II
10/M	72	Resection of a liposarcoma relapse (abdominogenital)	Right myocutaneous ALT with vastus lateralis (19×6.5)	0/13 M	AHT, C, CVI, MN, RT, UI/III
11/M	59	Resection of an adenocarcinoma relapse (abdominoperineal)	Right fasciocutaneous ALT (22×6)	0/6 M	RT, C/II
12/F	77	Resection of a vulvar squamous cell carcinoma (perineogenital)	Bilateral fasciocutaneous ALT (n/a)	IIIb (suture insufficiency perianal)/8 M	RT, C, UI, SIp/II
13/M	61	Resection of a rectal adenocarcinoma (perineal)	Left myocutaneous ALT (30×8)	II (decent wound healing disorder donor site)/6 M	RT, C, UI, SIp/IV
14/M	71	Fournier gangrene (perineogenital)	Bilateral fasciocutaneous ALT and sartorius (n/a)	IIIb (wound healing disorder recipient site)/6 M	C, MN, WI/IV
15/M	54	Fournier gangrene (genital)	Right myocutaneous ALT (n/a)	IIIb (partial flap necrosis—>NPWT)/7 M	AHT, C, DM, RT, SIp/IV

AHT, arterial hypertension; BMI, if BMI < 30; C, present carcinoma; C2, alcoholic; CVI, chronic venous insufficiency; DCM, dilative cardiomyopathy; DM, diabetes mellitus; MN, malnutrition; n/a, not available/applicable; py, smoking in packyears; RT, previous radiotherapy; SIp, stool incontinence (presence of stoma); UI, urine incontinence; WI, wound infection

case in which the flap was primarily lost in an oncological patient who was suffering from a relapse of a liposarcoma in the right groin after receiving radiotherapy. One patient suffered from partial skin necrosis, which resulted in partial flap loss, and one patient developed lymphedema at the donor site. In another case, the appearance of a seroma required further surgical intervention. There were seven cases of wound dehiscence, which were treated surgically in five cases and conservatively in two. Wound dehiscence was successfully handled with negative pressure wound therapy (NPWT) in two cases. Two of the wound healing problems appeared at the donor sites and five at the recipient site. There were no other donor site complications in our series. Split-thickness skin grafts were not required to cover donor site defects. Because the flaps were adequately designed preoperatively, all donor sites could be closed primarily. Although all reconstructions were complex and in patients with multiple comorbidities, 18 of the 19 flaps resulted in a successful reconstruction. In cases of extensive transmuscular dissection or with myofasciocutaneous flaps, active physiotherapy and crouches were added for mobilization for the first 6 weeks. Two patients developed a postoperative wound dehiscence which could be treated conservatively. No long-term donor site morbidity was observed, potentially due to the fact that rather bilateral ALT flaps were used for larger defects than extensive single-side ALT flap. The reconstructed areas all remained in good functional condition during follow-up, and the cosmetic outcome was satisfactory for all flaps.

The following sections review the pedicled ALT flap cases in each of the abdominal, perineal, and genital regions. Due to the immediate proximity of these regions, the regions often overlap, and some cases are therefore presented or described in multiple categories below.

Abdominal

Our series included five cases of pedicled ALT flaps being used to cover an abdominal defect. One patient had an extensive defect following the excision of an abdominoperineal myxoid liposarcoma ($14 \times 10 \times 11$ cm). This defect was reconstructed with a myocutaneous ALT flap that provided sufficient bulk to fill the dead space. In the second patient, an abdominal soft tissue defect produced by the resection of a vaginal squamous cell carcinoma infiltrating the anterior abdominal wall was reconstructed using bilateral fasciocutaneous ALT flaps. The third patient had an abdominal defect that was treated with a 19×6.5 cm unilateral myocutaneous ALT flap following the excision of a liposarcoma relapse. In the fourth case, a 22×6 cm pedicled ALT flap was used to cover an abdominoperineal defect after adenocarcinoma exenteration.

Figure 1A-E illustrate the fifth case, which was the reconstruction of an extensive abdominal soft tissue defect caused by the resection of suprapubic abdominal wall metastases arising from a colorectal adenocarcinoma (Fig. 1A). The posterior laparotomy scar was closed by the posterior rectus sheath with the rectus muscle still vascularized caudally

Fig. 1 Intraoperative view after tumor resection (**A**), closure of the posterior rectus sheath (**B**), inserted mesh (**C**), ALT insetting (**D**), tension-free closure of the defect and direct closure of the donor site (**E**)
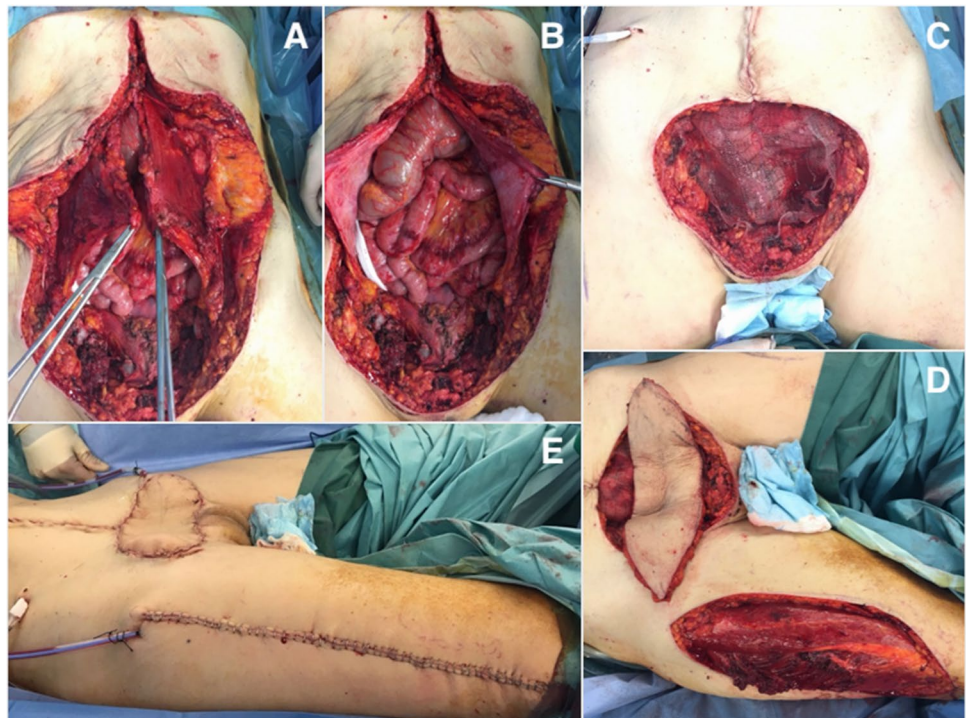
(Fig. 1B). A mesh was subsequently inserted and fixed to the symphysis, overlapping all wound margins by 5 cm, and the anterior rectus sheath was then closed (Fig. 1C). The remaining soft tissue defect was covered using a fasciocutaneous ALT flap. The flap (28×8 cm) was raised in a standard fashion, by tunneling under the rectus femoris muscle and then transferring the flap into the defect (Fig. 1D). The procedure resulted in tension-free conditions on all sides (Fig. 1E). The patient developed postoperative anemia and required blood transfusions. Twenty-one days after the operation, a seroma of the abdominal wall occurred and was drained without signs of bacterial contamination. No other complications were reported within the 6-month follow-up period.

Perineal

In our study, the nine perineal ALT flap cases encountered in an oncological setting were often against the background of a major resection, chemotherapy, and prior irradiation, which led to the wounds being poorly vascularized. All the reconstructive procedures were performed simultaneously with tumor resection, including two cases that used bilateral flaps. The defects originated from an anorectal carcinoma of the adeno or squamous cell type in four cases, from a liposarcoma in two cases, and from a carcinoma of the vagina or vulva in three cases. The vaginal and vulvar reconstructions are discussed in the following section. Preoperative radiotherapy was performed in all but one case. In one case, a musculocutaneous ALT flap was combined with a contralateral gracilis flap to obtain more bulk.

Figure 2A-D demonstrate a case where a vaginal squamous cell carcinoma infiltrated the pubic symphysis, anterior abdominal wall, and paravaginal soft tissue, reaching the mucosa of the urinary bladder and resulting in a vaginovesical fistula. The exenteration of this carcinoma led to an opened abdominal cavity and missing abdominoperineal soft tissues (Fig. 2A). To prevent elution of the intestines and the prevention of hernia, we sutured a mesh to the pecten ossis pubis and to the surrounding soft tissues. The 20×30 cm secondary tissue defect, which remained above the mesh, was covered using a bilateral ALT flap. The same surgical procedure was performed on both sides: The ALT flaps were dissected subfascially, with two suitable perforators found on the left flap and one on the right, and then the flaps were tunneled under the rectus femoris muscle and transferred into the defect without tension (Fig. 2B and C). The donor sites were primarily closed. The patient developed postoperative anemia and required a blood transfusion. One month after the operation, a seroma appeared on the right medial thigh and was punctured and drained. The patient was discharged 1 month postoperatively in good general condition and without any signs of wound healing problems. However, during the postoperative course after discharge, a therapy-resistant chronic seroma appeared on the right groin. The wound healed properly after surgical excision and multiple microscopic lymphatic vessel ligatures. No further complications were reported within the 6-month follow-up period (Fig. 2D).

Fig. 2 Intraoperative views after tumor resection (**A**), insetting of the bilateral ALT flaps (**B**), tension-free closure of the defect (**C**), follow-up view 6-month postoperative (**D**)
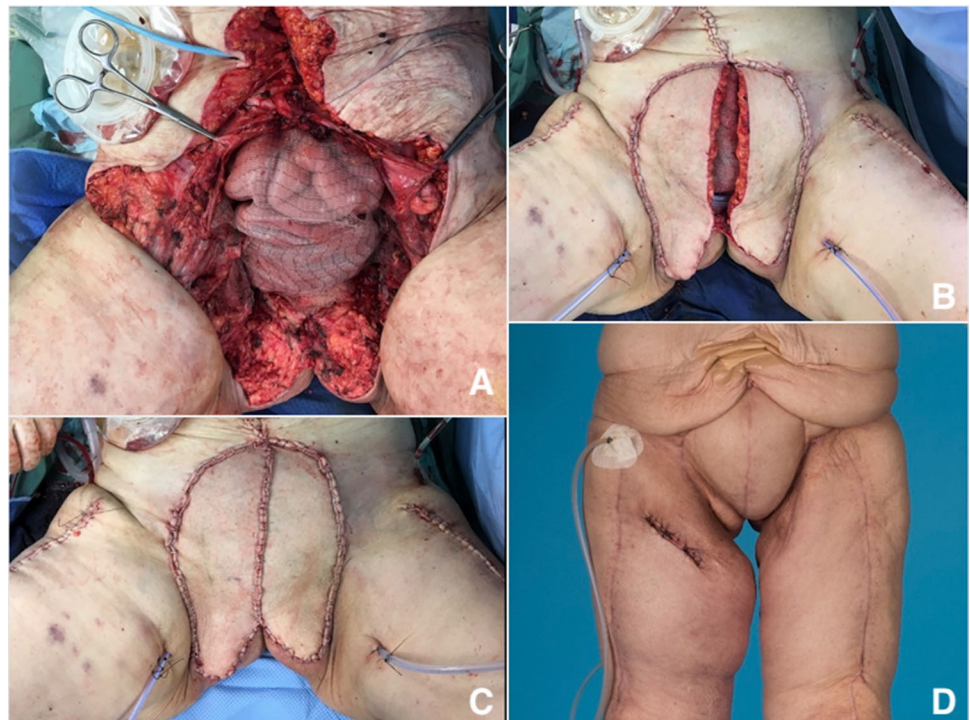
Genital

In the past 5 years, we have reconstructed seven genital defects with pedicled ALT flaps, including four in women and three in men. For large female genital defects, the best possible appearance and defect closure of the vulva can be achieved with a bilateral reconstruction. Bilateral flaps were used in three of the female cases and one of the male cases. In another male patient, the ALT flap was combined with parts of the underlying vastus lateralis muscle. Of the two genital soft tissue defects that resulted from extensive debridement due to Fournier gangrene, one was reconstructed with a bilateral fasciocutaneous ALT flap in combination with the sartorius and one with a unilateral myocutaneous ALT flap. In the case of a 57-year-old woman with bilateral ALT flaps, the symphysis had to be resected following a hemivulvectomy and pelvic and periportal lymphnodectomy in order to achieve R0 tumor resection. The pelvis was reconstructed with a free fibula transplant 6 days after the tumor was resected. The vascular stem of the transplanted fibula thromboembolized postoperatively, and the patient's postoperative complications should therefore be evaluated in the context of the fibula transplant.

In the case shown in Fig. 3A-D, a gynecologist performed a posterior exenteration with resection of the anus and a right hemivulvectomy to treat a squamous cell carcinoma of the posterior commissure of the vagina. Perineogluteal suture dehiscence was observed 19 days postoperatively (Fig. 3A). After wound debridement and multiple NPWT changes, the defect was reconstructed using a fasciocutaneous ALT flap performed 1 month after the primary operation. The perforators were located with a hand-held Doppler and a 20×6 cm spindle-shaped flap was identified (Fig. 3B). The flap was then pulled through a tunnel connecting the medial thigh with the perineum. The ventral and dorsal flap ends were then deepithelialized (4×3 cm) and inserted as a seal periurethrally (Fig. 3C). The donor and recipient sites were closed without tension. A vital and well-functioning flap result was observed at the 3-month postoperative control examination (Fig. 3D).

Discussion

The objective of this retrospective analysis was to demonstrate the variety of indications for the pedicled ALT flap in abdominal, perineal, and genital soft tissue reconstruction. Based on our analysis, the pedicled ALT flap provided adequate coverage of voluminous defects in these regions and achieved the ultimate aim of restoring shape and function. Since Song et al. [3] first reported the use of an ALT flap in 1984, the technique has become a workhorse for soft tissue reconstruction throughout the body because the flap can be composed in many different ways and has low donor site morbidity [2]. Owing to the early and extensive experience with free ALT flaps for head and neck soft tissue reconstruction, the pedicled ALT flap has become part of the plastic surgeon's armamentarium for the reconstruction of regions adjacent to the donor site [11]. Although it has not yet been

Fig. 3 Preoperative view (**A**), flap design based on the defect (**B**), ALT insetting (**C**), follow-up 3 months postoperative (**D**)
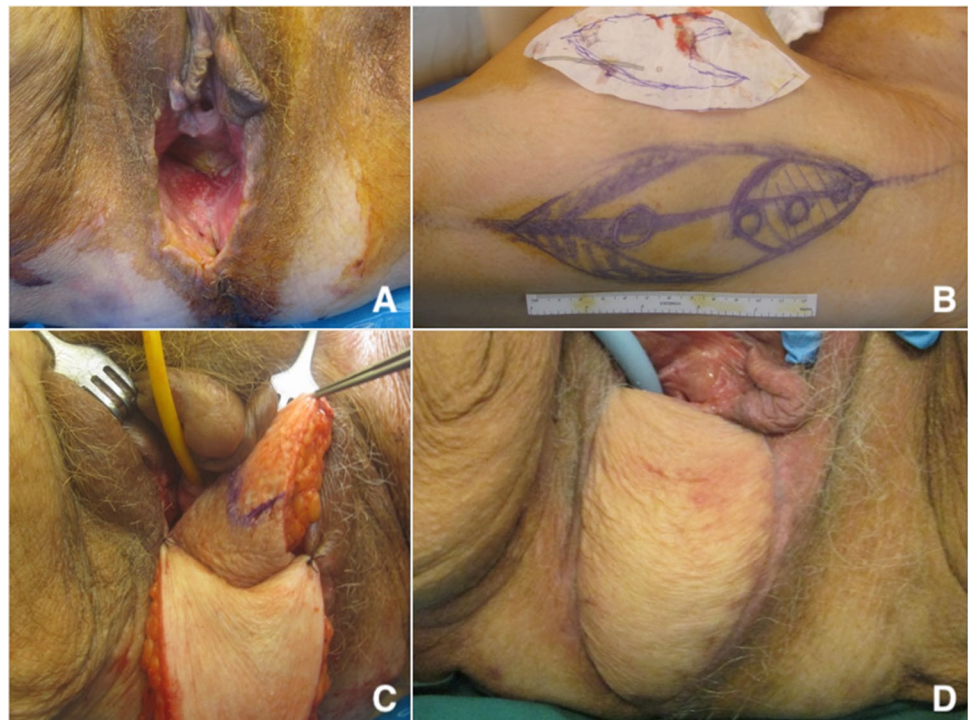
used to the same extent as the free ALT flap, the pedicled ALT flap has successfully been used for soft tissue reconstruction of the perineum, genital zone, and lower abdominal wall [4, 11–16]. In 2012, Kayano et al. compared the outcomes of free and pedicled ALT flaps in complex abdominal wall reconstructions and found that the reconstruction time required for free ALT flaps was much longer due to the need for microvascular anastomosis, even in the absence of any other differences between the two techniques [17].

Reconstructing soft tissue defects of the perineum, lower abdominal wall, and genital area poses a unique challenge for plastic surgeons because wounds in these areas are often extensive, irradiated, or contaminated, or have previously been operated on. Primary or secondary closure, skin grafting, and even local flaps do not adequately restore form and function. Any successful reconstructive strategy in these areas requires the transfer of reliable, sufficient, non-irradiated, and well-vascularized tissue. Given the location and size of the defects in our cohort, the irradiation of the surrounding tissue, and the cause of functional sequelae, we ruled out muscle flaps such as the sartorius, gracilis, rectus abdominis, rectus femoris, and tensor fascia lata and instead chose the pedicled ALT flap as our reconstruction option. Other regional flaps are of limited use for covering extensive defects in post-oncological cases in these regions, as regional flaps are often within irradiated areas or harvesting the flap requires an intraoperative position change.

Using the pedicled ALT flap for the reconstruction of these defects provides a reliable skin area in the vicinity of the defect and a long pedicle that allows for a wide rotational arc and extended reach. The ALT flap is particularly useful because it contains different tissues that can be used to resurface deep defects and providing a large cutaneous island. It can be used in various ways, including a myocutaneous or fasciocutaneous flap, and can even be used as a sensate flap if the lateral femoral cutaneous nerve is preserved. To gain more bulk, the ALT flap can be dissected as a composite flap with varying amounts of the vastus lateralis muscle. The fascia of the tensor fascia lata can also be incorporated to acquire more stability for reconstructing the abdominal wall [18]. The ALT flap successfully fills dead space while dividing the abdominal from the pelvic space. In all our cases, harvesting the ATL flap eliminated the need to change the patient's position during surgery and therefore minimized the operative time. Disadvantages of the ALT flap include the large variation in perforators among individuals and its thickness in obese patients, especially in cases where thin, pliable skin is needed [19].

Abdominal

Kimata et al. [12], Friji et al. [11], and Lin et al. [4] each reported their experience with three cases that used pedicled ALT flaps for abdominal wall reconstruction. The rectus abdominis flap, in its either vertical or horizontal design, has historically been the workhorse for lower abdominal defects despite it having a much greater donor site morbidity; for example, donor sites would often show abdominal wall weakness or develop hernias or bulging. Furthermore, previous surgery or interference with ostomy placement may preclude the harvesting of rectus abdominis flaps [20]. According to the literature, most of the recent experiences with abdominal wall reconstruction described free flaps, such as the latissimus dorsi, anterolateral thigh, or tensor fascia lata flaps [21]. In 1997, Ninkovic et al. [22] described four cases of free innervated latissimus dorsi muscle flaps being used as a suitable reconstructive option for restoring the functional and anatomic deficits of the abdominal wall in full-thickness abdominal wall defects. The main disadvantages of this flap were its inadequate size and dimensions and its functional and esthetic morbidity at the donor site. In two of these four cases, a mesh was used to ensure sufficient strength and stability of the abdominal wall. Twenty years later, Bodin et al. [23] presented a case series where nerve conduction testing of two innervated free latissimus dorsi flaps was unfortunately unable to detect muscular function in the follow-up period. In our opinion, the ALT flap is an ideal flap for lower abdominal wall reconstruction due to its proximity to the defect and low donor site morbidity. To add extra strength to a lower abdominal wall defect, it may be necessary to use mesh or incorporate a significant portion of fascia [24].

Perineal

In our study, the nine perineal cases encountered in an oncological setting were often against the background of a major resection, chemotherapy, and prior irradiation, which led to a poorly vascularized wound bed. Modern treatment of different malignancies around the perineal region often includes aggressive surgery to achieve oncological safe margins [25], resulting in large intrapelvic cavities and perineal wounds. Local skin grafts or flaps, such as the Singapore or Lotus flaps, are therefore of limited use due to the extent of the defect, previous irradiation, and the high bacterial load in this region. The flaps commonly used for large defects of the perineum are free or pedicled flaps, such as gracilis muscle, vertical rectus abdominis myocutaneous (VRAM), tensor fascia lata, vastus lateralis muscle, or ALT flaps [26]. Horch et al. [27] analyzed 100 VRAM flaps in 2014 and demonstrated that simultaneous pelvic reconstruction was clearly advantageous, despite a perineal wound complication rate of over 10% and major donor site complications in 6% of the cases. Due to the risk of postoperative bulging and hernia development associated with the VRAM flap, we currently prefer the ALT flap over the VRAM flap, especially if the

abdominal wall has been involved in a previous laparotomy or ostomy. In addition to the various advantages described above, the ALT flap can be harvested as a compound or chimeric musculocutaneous flap alongside a portion of the vastus lateralis muscle. Scaglioni's case report from 2018 [28] outlines in detail how a sensate, chimeric ALT flap is a possibility to be considered.

Genital

In their review, Brodbeck et al. [26] demonstrated that the VRAM flap is suitable for concurrent reconstruction of the perineum and vagina, while in a 2006 paper, Zelken et al. [24] reported a preference for the fasciocutaneous ALT flap for vaginal and external genital reconstructions because it has the least bulk. After reviewing fifteen cases, Gentileschi et al. included the ALT flap among the first-line options for reconstructing complex defects resulting from vulvar cancer [29]. We similarly believe that the fasciocutaneous analog of the ALT should be the first choice for genital defect reconstruction. Regional alternatives, such as the tensor fascia lata or gracilis flap, have shorter pedicles and less versatility and would not have provided sufficient coverage of the extensive defects in our study. The ALT can also be used for partial vaginal wall reconstructions, as shown in patient 2 in our study (Fig. 3A-D). For defects of the perineum and intimate area, the ALT provides durable skin and soft tissue that is superior to local skin grafts because it is better able to withstand the maceration caused by frequent urinary or fecal contamination [14].

In their algorithm for determining the appropriate flap for vulvar reconstructions, Gentileschi et al. [30] proposed that pedicled flaps were the best solution. They suggested that the traditional V–Y flap or Lotus flap are valid options and that an abdominal or ALT flap could be used if the mons pubis is involved. There have also been reports of the ALT flap being used successfully for partial [31] and total [32] penile reconstruction and for total scrotal reconstructions [33, 34], suggesting that the ALT flap is a viable option for reconstructing male intimate parts. However, in the well-fed Western population, the ALT flap is often unappealingly bulky and pale compared to perineal skin for the purpose of genital reconstruction.

The limitations of our retrospective study are the small number of patients and the uncontrolled study design. Due to these limitations, it was not possible to draw conclusions about the relationship between preoperative comorbidities and postoperative complications. Nonetheless, our series contributes valuable information to the worldwide experience with using pedicled ALT flaps for reconstructing defects in a complex anatomical region and a heterogeneous patient population.

Conclusions

The pedicled ALT flap provides a favorable alternative for soft tissue coverage of abdominal, perineal, and genital defects created after extensive resections. A major advantage of the pedicled ALT flap is that it is located outside of the irradiated area but still has adequate range to cover the abdomen, perineum, and genitals without the need for microsurgical anastomosis. Other advantages include its variability in size, low donor site morbidity, and the ability to harvest multiple tissue components in different combinations depending on the desired outcome.

Compliance with ethical standard

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was performed in accordance with the Cantonal Ethics Committee of Zurich (BASEC-ID Nr.: 2019–00151).

Informed consent Informed consent was obtained from all individual participants included in the study.

Patient consent Patients signed informed consent regarding publishing their data and photographs. Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

Conflict of interest Jan A. Plock is a consultant for MediWound Germany, Integra Lifesciences, and Nanomedic. Stephan Alois Steiner, Riccardo Schweizer, Holger Klein, Matthias Waldner, and Pietro Giovanoli declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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