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Review Article

Primary flap closure of perineal defects to avoid empty pelvis syndrome after pelvic exenteration in gynecologic malignancies: An old question to explore a new answer

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ABSTRACT

Pelvic exenteration (PE) is a radical oncological surgical procedure proposed in patients with recurrent or persistent gynecological cancers. The radical alteration of pelvic anatomy and of pelvic floor integrity can cause major postoperative complications. Fortunately, PE can be combined with reconstructive procedures to decrease complications and functional and support problems of pelvic floor, reducing morbility and mortality and increasing quality of life. Many options for reconstructive surgery have been described, especially a wide spectrum of surgical flaps. Different selection criteria have been proposed to select patients for primary perineal defect flap closure without achieving any strict indication of the best option.

The aim of this review is to focus on technical aspects and the advantages and disadvantages of each technique, providing an overview of those most frequently used for the treatment of pelvic floor defects after PE.

Flaps based on the deep inferior epigastric artery, especially vertical rectus abdominis musculocutaneous (VRAM) flaps, and gracilis flaps, based on the gracilis muscle, are the most common reconstructive techniques used for pelvic floor and vaginal reconstruction.

In our opinion, reconstructive surgery may be considered in case of total PE or type II/III PE and in patients submitted to prior pelvic irradiation. VRAM could be used to close extended defects at the time of PE, while gracilis flaps can be used in case of VRAM complications.

Fortunately, numerous choices for reconstructive surgery have been devised. As these techniques continue to evolve, it is advisable to adopt an integrated, multi-disciplinary approach within a tertiary medical center.

1. Introduction

Pelvic exenteration (PE) is a radical oncological surgical technique that is performed as a salvage procedure in patients with recurrent or persistent gynecological cancers often after radiotherapy.

PE was first described by Brunschwig in 1948 as a treatment for recurrent or locally advanced cervical carcinoma [1]. It consists in the partial or total removal of the pelvic structures. Anterior PE (APE) includes partial or total excision of the vagina, removal of the genital organs and bladder and is performed in patients with malignancies involving the bladder. Posterior PE (PPE) includes partial or total excision of the vagina, removal of the genital organs and rectum and is

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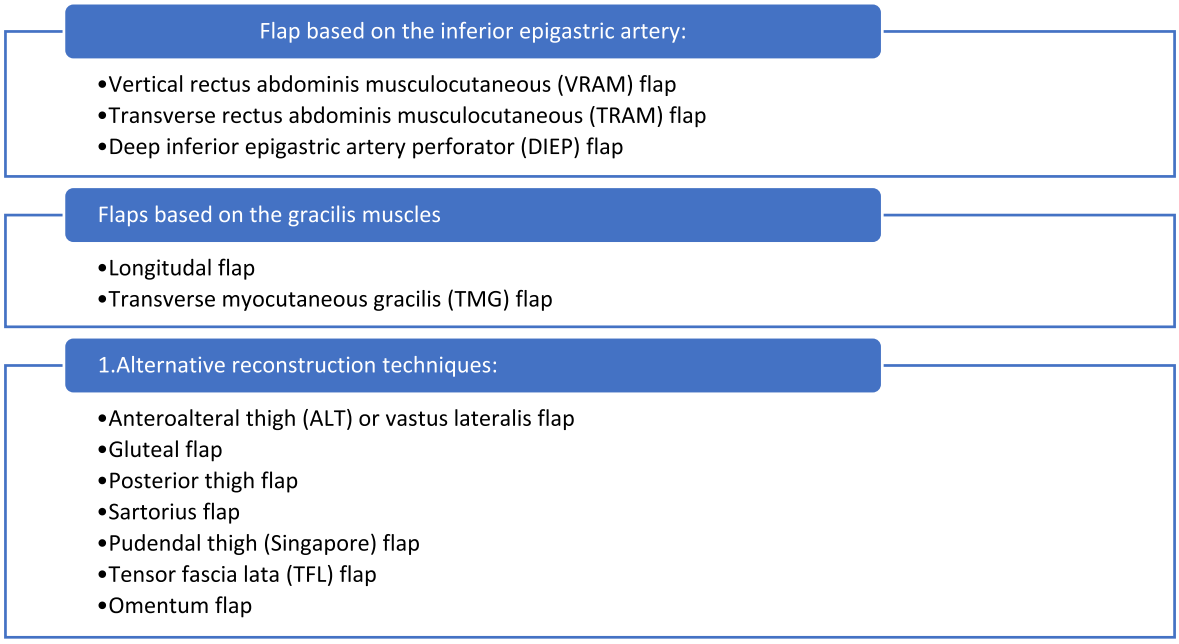


Fig. 1. Surgical flaps.

performed in patients with malignancies involving the rectum. Total PE (TPE) comprises partial or total excision of the vagina, removal of the rectum, genital organs and bladder. Depending on the extent of the surgery, PE is classified as type I (supralevator), type II (infralevator), or type III (infralevator with vulvectomy) [2]. The extent of the excision of the vulva depends on tumour location and ranges from no removal to extensive excision of skin and soft tissue from the perineal and perianal area.

The increased radical and wider resections with clear margins which are associated with safer procedures have been enabled by advances in anesthesia, intensive care medicine, patient selection and surgical techniques [3]. As a result, five-year overall survival after PE has increased reaching 40 % [4].

The radical alteration of pelvic anatomy and of pelvic floor integrity can cause postoperative complications and functional problems, especially in the case of preirradiated field [5]. Postoperative complications are common after PE, ranging from 56 % to 94 %[4,6–104,] [6–10], and include digestive fistula, infection, pelvic abscess [11], perineal wound complications and intestinal occlusion [12]. It is thought that the empty space left in the pelvis after PE may lead to fluid accumulation and small bowel translocation into the pelvis, with an increased risk of pelvic abscess, bowel occlusion and fistula formation, perineal herniation and fluid discharge with perineal wound dehiscence. These sequalae of events are known as 'empty pelvis syndrome'.

In addition, PE is linked to a considerable decrease of quality of life, due to the presence of one or more stoma and alterations in body image and sexual function.

Consequently, PE can be combined with reconstructive procedures to decrease complications and increase quality of life. Reconstructive surgery can decrease postoperative complications, functional and support problems of the pelvic floor, reducing the morbidity and mortality associated with PE. The replacement of the empty pelvic dead space left after PE with healthy and viable tissue [13,14], consequently, reduces the risk of fistula formation, occlusions, perineal bowel herniation, empty pelvis syndrome and pelvic abscesses.

In addition, reconstructive surgery could allow the creation of a neovagina, improving quality of life and sexual functions, but this procedure could be reserved for motivated women in good health conditions. In addition to the psychological benefits, vaginal reconstruction also eases speculum examination during successive gynecological-oncological follow-up visits.

Perineal/vaginal reconstructions can be carried out during the same surgical procedure or as secondary surgery. A variety of reconstruction techniques were carried out after PE using both autologous and synthetic material. Studies have shown that autologous reconstruction is better than synthetic mesh- or acellular dermal matrix-based solutions [15] because these techniques have an increased rate of infection and fistulas.

This paper focuses on giving the gynecologic oncologist an overview of the most frequently used reconstructive techniques for the treatment of perineum, genital, and pelvic floor defects after radical resection of pelvic structures for gynecological tumors.

2. Surgical flaps

A flap is defined as an area of tissue with a defined blood supply (Fig. 1). Flaps may be made up of just one type of tissue or multiple types of tissue. Flaps composed of a single type of tissue include skin, fascia, muscle, bone, and visceral flaps (the most common being the omental flap). Most common composite flaps include myocutaneous and fasciocutaneous flaps.

Tissue relocation from an area adjacent to the defect requiring coverage is known as a local flap. It may be categorized based on its geometric design, it may be advanced, or both. Advancement flaps include single pedicle, bipedicle, and V–Y flaps.

Regional flaps are not immediately adjacent to the defect. These are created by detaching one end of the target tissue and delivering or tunnelling the flap subcutaneously to the recipient site, with the vascular pedicle still connected to the donor site. Many regional flaps are myocutaneous, therefore, the morbidity of muscle harvest and loss of the donor muscle function has to be taken into account. These flaps are usually robust, with a reliable vascularization and have a large bulk of tissue useful for reconstruction.

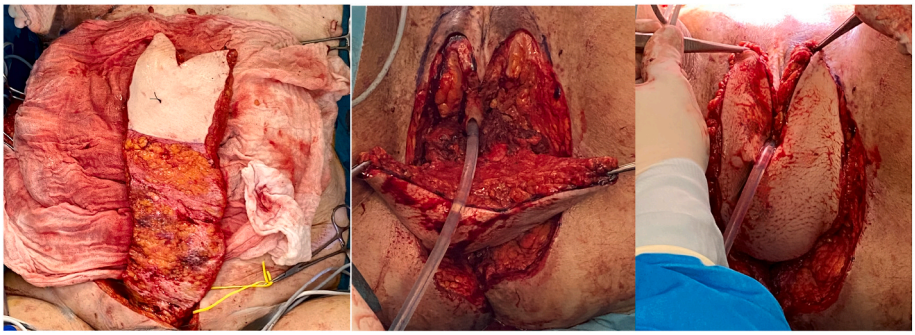
Distant flaps use tissue from a noncontiguous anatomical site and can be transferred over a large distance as pedicled or free flaps. Free flaps are completely detached from their native site with subsequent reanastomosis of their blood vessels at the destination site.

Perforator flaps are based on the concept that perforator vessels pass through the muscle or fascia from a major artery before reaching the subcutaneous plane, and this may allow the underlying fascia and

Table 1
General characteristics of the evaluated studies.

Author	Year	Study design	Total number of patients analyzed	PE with reconstruction for gynaecologic cancer	Type of reconstruction	PE with reconstruction for gynaecologic cancer	Type of PE	Previous RT/CRT
Zhang [23], 2022	2014–2022	Retrospective cohort	31	31	depithelized gracilis adipofascial flap	31	TPE	NR
Van Ramshorst [37], 2020	2003–2016	Retrospective cohort	87	29	VRAM	29	NR	NR
Kaartinen [24], 2014	2011–2014	Retrospective cohort	12	12	TMG	12	TPE	NR
Jurado [48], 2009 Qiu [16], 2013	1986–2010	Retrospective cohort	75	34	5 DIEP 8 Singapore flap 21 TRAM	34	APE 9 PPE 1 TPE 24	33
Berger [17], 2011	1993–2011	Retrospective cohort	46	46	VRAM	46	APE 7 PPE 4 TPE 35	32
Smith [45], 1998 Goldeberg [15], 2006	1987–2003	Retrospective cohort	103	36	VRAM	36	TPE	36
Mirhashemi [41], 2002	1988–2001	Retrospective cohort	104	11	4 VRAM, 1 TRAM, 6 TMG	11	NR	NR
Copeland [40], 1988	1974–1997	Retrospective cohort	151	104	TMG	104	TPE	104

VRAM = vertical rectus abdominis musculocutaneous flap.
TRAM = transverse rectus abdominis musculocutaneous flap.
DIEP = deep inferior epigastric artery perforator flap.
TMG = Transverse myocutaneous gracilis flap.
RT = radiotherapy.
CRT = chemo-radiotherapy.



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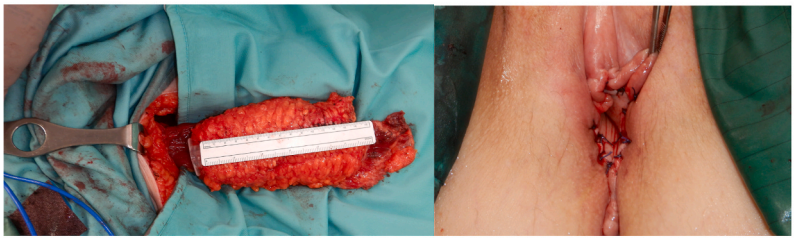

b

Fig. 2. Vertical rectus abdominis musculocutaneous (VRAM) flap a) perineal defect closure b) vaginal reconstruction.

muscle to be spared [16].

Choosing the kind of flap to be used is based on the clinical scenario, scope of coverage needed, and the experience and personal choice of the surgeon.

In Table 1 we have summarized the main studies describing the surgical outcomes related to different flap reconstruction types following pelvic exenteration for gynecological malignancies.

2.1. Flaps based on the inferior epigastric artery

The most common flaps used for pelvic floor and vaginal reconstruction are flaps based on the deep inferior epigastric artery, including the vertical rectus abdominis musculocutaneous (VRAM) flap (Fig. 2), which is the most commonly used, the transverse rectus abdominis musculocutaneous (TRAM) flap, or, more recently, the deep inferior epigastric artery perforator (DIEP) flap [2]. The rectus abdominis muscle has two vascular pedicles, the deep inferior epigastric artery and the

Fig. 3. Gracilis flap.

superior epigastric artery, either one of which can support the muscle and the overlying subcutaneous fat and skin. After isolating the deep inferior epigastric artery, the flap, made of muscle alone or muscle and the overlying skin and fat, is rotated intra-abdominally to fill the pelvic defect. Depending on the location and size of the defect, the skin paddle can be oriented vertically, obliquely or transversely. It is particularly useful in reconstruction of the posterior perineum and posterior vaginal wall and it can also be used for total vaginal reconstruction.

On the other hand, this type of flap has the advantage of providing a large amount of tissue to reconstruct the perineum or the vagina, with a large bulk of tissue filling the pelvic dead space, thus decreasing the overall complication rate. Moreover, these flaps can be harvested taking advantage of the vertical midline laparotomic incision utilized for the PE.

However, this type of flap interferes with abdominal wall integrity, and this may be a problem because many PE patients require urinary diversion and/or end colostomy.

These flaps could be connected to donor site morbidity, including abdominal wall weakness, bulging, or hernia and delayed wound healing. If primary, tension free abdominal wall closure is not possible, the possibilities are, at the skin level, secondary intention or delayed primary closure or closure with a flap and, at the myofascial level, mesh utilization.

Nevertheless, there might be some situations in which the use of rectus abdominis flaps is limited or precluded, such in the case of previous surgeries with a transverse low-abdominal incision (especially Maylard incision), or in the event of prior irradiation, where deep inferior epigastric vessels may be compromised [17]. Another limitation in the use of rectus abdominis flaps is the presence of both fecal and urinary diversions.

In 2017, modifications of the myocutaneous flap were described by Cibula et al. in order to reduce donor site complications. The modified rectus abdominis myoperitoneal (MRAM) flap consists of the rectus abdominis muscle, posterior fascia and peritoneum, while the anterior fascia and the skin are kept intact [18]. Since it is carried out primarily for pelvic floor reconstruction only, it can be used when no vaginal or perineal reconstruction is planned.

With the advent of perforator flaps, the deep inferior epigastric artery perforator (DIEP) flap has gained in popularity, mainly due to the chance it offers to spare rectus abdominis structure and function. This flap which can be used as a versatile local or free flap, is based on perforators from the deep inferior epigastric artery, which gives it a robust and reliable blood supply. Similarly, to the MRAM flap and to an even greater extent, the DIEP flap reduces donor site morbidity, with the additional advantage of sparing the rectus abdominis muscle and its anterior fascial sheet. The amount of fat tissue offered by the abdominal wall is the bulkiest among the perforator flaps used in pelvic and perineal reconstruction and it is usually enough for both vaginal reconstruction and filling the pelvic dead space. The DIEP flap does not injure the anterior rectus fascia or the underlying rectus abdominis muscle, consequently its use can potentially eliminate the risk of donor site complications. However, this technique demands advanced surgical skill [16]. DIEP flap necrosis was reported in the case of free flaps while this complication was rare in the case of pedicle flaps [19]. The DIEP flap is characterized by a more lengthy procedure time the VRAM flap [16].

2.2. Gracilis flaps

The second most used are the flaps based on the gracilis muscle (Fig. 3). The gracilis is the most superficial adductor muscle of the medial thigh and is supplied predominantly by the medial femoral circumflex femoral artery with additional minor perforators arising from the obturator artery. Although the pedicled gracilis flap is mainly used in perineal reconstruction, its use extends to defects involving the groin, thigh, genital, and gluteal region. It does not impair abdominal wall integrity and it may be used as a pedicled flap, a free flap, or a perforator flap. It may be a muscle only or myocutaneous flap. The incision on the medial aspect of the thigh can be oriented vertically or transversally. Historically, the musculocutaneous gracilis flap consisted of a vertical skin island lying longitudinally on the gracilis muscle. However, it is often associated with distal necrosis. Further studies have shown that a better vascularity of the skin paddle could be achieved by placing the skin flap horizontally on top of the proximal third of the gracilis muscle [20]. The transverse myocutaneous gracilis (TMG) was first described in 2013 by Kolehmainen et al. [21]. It can be raised as a unilateral or bilateral flap, depending on the reconstructive requirements. Bilateral TMG reconstruction is required for TPE patients who desire vaginal reconstruction and after PPE with vaginal resection extended to the lateral wall. Bilateral TMG flaps are also indicated for patients submitted to concomitant radical vulvectomy. Proximity of the myocutaneous gracilis flap to the pelvis and external genitalia makes it a logical option for reconstruction after PE.

The lack of perforators causing poor reliability of skin paddle perfusion, the small muscle volume and the limited excursion are the most important limitations of this flap [22].

In 2022, Zhang et al. described a depithelized gracilis adipofascial flap. Since there is no myocutaneous artery branching into the skin in the segment of the gracilis, in the traditional gracilis musculocutaneous flap distal necrosis of the musculocutaneous flap may occur. The depithelized gracilis adipofascial flap technique reduces the incidence of this complication. Compared with the gracilis muscle flap, the gracilis adipofascial flap has a larger volume and can be used for reconstruction of larger defects [23].

Moreover, gracilis flaps do not create abdominal wall defects, do not complicate ostomies and operative time is shorter than VRAM/TRAM or DIEP [24]. Given the fact that it has the advantage of having a constant neurovascular pedicle, the skin paddle over the distal third of the muscle has a less reliable vascularity which makes it more susceptible to perineal wound or flap complication when compared to a flap based on the rectus abdominis [25]. However, if we compare muscle only flaps this gap disappears. Lastly, it has to be considered that, since bulk offered by a single flap is limited or when a vaginal reconstruction is desired, the need for a bilateral flap to obliterate dead space exists.

2.3. Alternative reconstruction techniques

These alternative reconstruction options have been less frequently described following gynecologic oncology procedures.

2.3.1. Anterolateral thigh flap

Thanks to its wide arc of rotations, the anterolateral thigh (ALT) or vastus lateralis flap has been described for the reconstruction of several defects including perineal and pelvic cavity reconstruction but few records reported this technique in patients with gynecologic malignancies [26]. The lateral circumflex femoral artery, a branch of the profunda femoris artery, vascularizes the ALT flap. Considering that the vastus lateralis muscle and skin of the anterolateral thigh have the same blood supply, the ALT flap can be either a myocutaneous or a perforator flap, including only skin, or a free flap [22]. If a muscle only flap is needed, the vastus lateralis can be used. In case of groin and pelvic cavity reconstruction, the transposition is made through an inguinal route, whereas the flap is tunneled subcutaneously when used for perineal reconstruction. It leads to good results with low donor site morbidity and acceptable minor complications [27]. Obese patients with short thighs may not be good candidates for this procedure.

2.3.2. Superficial circumflex iliac artery perforator flap

The Superficial Circumflex Iliac Artery Perforator (SCIP) flap provides several advantages for vulvar/perineal reconstruction, first and foremost proximity of donor and recipient sites and low complication rate. The dissection is very fast, especially when inguinal lymphadenectomy is performed because it provides direct access to SCIP vascular pedicles. The vascular anatomy of this flap also allows the harvesting of large pliable skin islands of different thicknesses, from very thin to bulky flaps [28,29].

2.3.3. Gluteal flap

Gluteal flaps can involve the use of the gluteus maximus (GM) muscle and overlying skin. The gluteal flap may be often performed as a fasciocutaneous flap without muscle and with low donor site complications. In this case flaps can be differentiated into superior gluteal artery perforator or inferior gluteal artery perforator flaps. The superior half of the GM is vascularized from the superior gluteal artery, while the inferior one from the inferior gluteal artery. Either the superior or the inferior half of the muscle can be used as a flap and the remaining part may maintain normal muscle function. This flap can be used as a rotational or V–Y advancement flap [27]. GM was recently mentioned by Wagstaff et al. in pelvic defect reconstruction [30]. Abdomino-perineal rectum excision with partial sacrectomy is the best procedure for a GM flap [31].

2.3.4. Posterior thigh flap

The posterior thigh (PTF) flap, also known as the gluteal thigh flap, is fasciocutaneous, located along the posterior aspect of the thigh and based on the descending branch of the inferior gluteal artery. It has been used since the 1980's for reconstructing defects of the perineum, vagina and pelvic cavity. Being a fasciocutaneous flap it is associated with low donor site morbidity and has a low complication rate [27].

2.3.5. Sartorius flap

The sartorius flap, also called the sartorius muscle "twist" flap, receives a segmental blood supply from the superficial femoral artery, which gives rise to approximately 6–7 branches to the muscle that enters the flap along its deep and medial section. This flap is created by detaching the sartorius muscle from its origin and twisting it along its long axis; the muscle is then fixed medially to the inguinal ligament and femoral sheath, when inguinal coverage is requested or directed to the perineum when used to cover perineal defects [27]. Sartorius flaps are often used following inguinal lymphadenectomy to protect the femoral vessels from infection and tumor recurrence [32,33]. The morbidity of donor site is low and the functional outcomes do not impact deambulation.

2.3.6. Pudendal thigh flap

The pudendal thigh (Singapore) flap was first described by Wee and Joseph from Singapore in 1989 as a useful option for vaginal reconstruction [34]. Woods modified the technique creating a peninsular instead of an island flap, an expedient which may increase flap blood supply [35]. The flap is obtained from the groin crease just lateral to the labia majora, with its base at the level of the posteriori fourchette, and consists of skin, subcutaneous fat and fascia. Including the deep fascia and epimysium of the adductor muscle decreases the risk of involuntary damage to neurovascular supply. The pudendal thigh flap receives its blood supply from the posterior labial arteries, branches of the perineal arteries, which derive from the internal pudendal arteries. This flap may be performed unilaterally for posterior vaginal reconstruction or bilaterally for the creation of a neovagina, whose apex should be secured to internal pelvic structures in order to minimize the risk of prolapse [27]. It can be used also for vulvar reconstruction. Singapore flaps have minimal donor site morbity.

2.3.7. Tensor fascia lata flap

The tensor fascia lata (TFL) muscle is located on the lateral part of the thigh and has the function of stabilizing the knee. Its vascular supply comes from the lateral circumflex femoral artery, which gives rise to multiple branches that enter the deep surface of the muscle. Due to its arc of rotation, the TFL flap, a myocutaneous flap, is generally not suitable for defects of the perineum or the pelvic cavity so, in patients with gynecologic malignancies, it is principally used to reconstruct defects of the groin and suprapubic area [27]. Even if associated with minimal functional morbidity it has been replaced by the more adaptable ALT flap.

2.3.8. Omentum flap

The greater omentum is a large peritoneal fold consisting of connective tissue, fat and lymphatics. It owns two dominant blood supplies coming from the right and left gastroepiploic arteries, which run within the anterior leaf of the omentum approximately 1.5 cm distal to the greater curvature of the stomach. The omentum could be pedicled on either the left or the right gastroepiploic vessels. The omental flap has been widely used in gynecologic oncology. Among its various uses it was employed in order to reduce complications after radical hysterectomy and pelvic lymphadenectomy, to repair vaginal fistulas, in reconstruction of the pelvic floor to form a lid on the inlet of the true pelvis after PE, and in vaginal reconstruction alone or combined with the use of biological or prosthetic materials [27]. It can be used alone, or in combination with different flaps, in the reconstruction of perineal defects. If available, and of sufficient volume, a pedicled omental flap can obliterate pelvic dead space with vascularized tissue, thus reducing the incidence of pelvic infection after PE; however, it does not provide sufficient mechanical support or any skin or muscle coverage [36]. A skin graft could be placed on the omental flap to allow partial vaginal reconstruction. In ovarian and serous endometrial cancers, omentectomy can be performed during the first surgery, so, often, the omentum is no longer available.

3. Discussion

During the treatment of recurrent gynecologic malignancies, pelvic reconstruction after PE is an essential component to be carefully planned and executed based on patient's short- and long-term outcomes.

Several selection criteria have been proposed to select patients for primary perineal defect flap closure after PE without achieving any strict indication of the best option.

Van Ramshorst et al. reported a selective approach to the management of perineal defects. They have indicated 4 clinical risk factors:

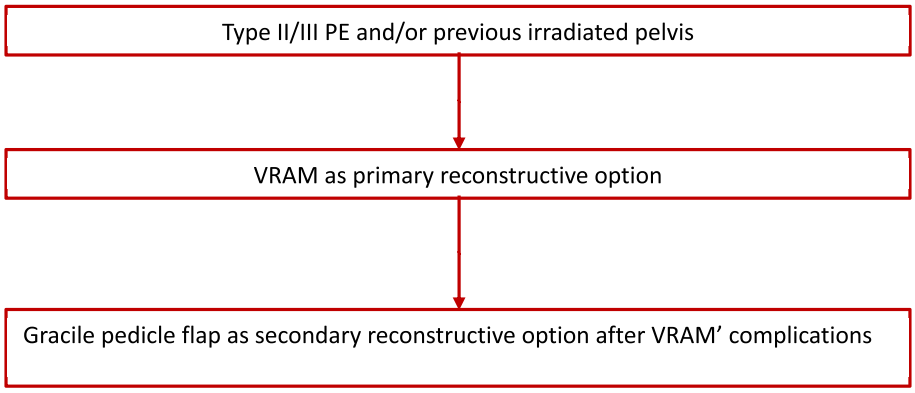

Fig. 4. Proposed surgical algorithm for reconstructive flap after type II/III PE previously irradiated.

abdominoperineal resection, pelvic radiotherapy, TPE, and sacrectomy. These together with other factors such as widespread skin involvement, or a physique requiring particular flaps, represent indications for VRAM use. On the other hand, if only one clinical risk factor is present, patients can be submitted to primary closure without increased morbidity [37]. Kaartinen et al. suggested that flap reconstruction should be performed in all TPE to prevent dead space formation and perineal evisceration or hernias [24].Several factors such as the type of PE, the size of defect, the characteristics and the blood supply of the locoregional tissue influence the choice of appropriate reconstruction surgery [38].

Although the different reconstructive techniques were the subject of several studies, a clear evidence-based reconstructive algorithm does not yet exist and there are no prospective studies to compare the different options.

Regarding pelvic and perineal reconstruction, a defect that requires only skin coverage may be appropriately reconstructed with a fasciocutaneous flap alone, which prevents the sacrifice of a muscle. Conversely, a defect that requires only dead space obliteration may be restored with a muscle flap alone, which reduces morbidity by allowing a tension-free closure at the donor site.

In 2016, Mericli et al. proposed an algorithm for choosing the ideal pedicled flap for each region involved in acquired pelvic defects. They proposed the use of the ALT flap to reconstruct defects in the region of the mons pubis; the VRAM flap for vagina, perineal raphe and major defect reconstruction; the gracilis flap for reconstruction of the labia majora; and the gluteal fasciocutaneous flap for isolated defects of the posterior perineum. In the case of additional dead space which needs to be filled, an omental flap may be added [39]. However, this study is based on a retrospective cohort with few cases.

Several authors do not agree about the limited use of the gracilis flap and they support its use in vaginal/pelvic floor reconstruction. In particular, TMG is considered a versatile tool for pelvic floor and vaginal reconstruction [2,40].

Myocutaneous flaps, especially rectus abdominis myocutaneous and gracilis myocutaneous flaps, are the most common reconstructive technique used during reconstruction after PE because they can be safely used for vaginal/pelvic floor reconstruction with acceptable operative morbidity. In addition, myocutaneous flaps are characterized by higher patient satisfaction [41].

Rectus abdominis flaps are characterized by higher incidence of mean donor site morbility (about 15 %) with reported risk of abdominal dehiscence of 5.5 %, wound infection of 4.2 % and incisional hernia of 3.3 % [42]. However, they are also characterized by bulk, adequate arc of rotation and reliable vascular supply with a low incidence of flap necrosis (about 9–19 %) [43] The VRAM flap is easier and faster to perform than DIEP reconstruction, but the rate of abdominal wall complications (i.e., abscesses, hernias, and fistulae) associated with the VRAM technique is higher because the flap is adherent to the rectus muscle containing the vascular pedicle.

The gracilis myocutaneous flap is a good alternative with shorter operative time and it is useful especially when the abdomen appears to be a poor donor site (previous surgery, poor quality of the perforators) because this technique does not impair abdominal wall integrity. Also, some authors prefer this technique when bilateral oustomies are need [44] because the flap from the abdomen is associated with significant donor site complications. However, the gracilis flap has a higher incidence of flap necrosis (11–37 %) [45]. In cases of large tissue loss in the perineal region bilateral gluteus maximus myocutaneous flaps are recommend but it not suggested for total vaginal reconstruction.

Several studies have shown how patient characteristics such as age, body mass index or number of comorbilites are associated with higher rate of complications [46].

In general, reconstruction at the time of surgical resection is preferable to delayed reconstruction. At the time of surgical demolition, the surgeon has an optimal exposure of the surgical field, including the blood supply, and the defect itself thus allowing an accurate assessment of reconstructive options. This obviates the need for the patient to undergo additional operations which could be more challenging due to a distorted surgical field with compromised vascular supply, and a more difficult evaluation of the true extent of the defect.

In our opinion, reconstructive surgery may be considered in case of TPE or type II/III PE and in patients submitted to prior pelvic irradiation. VRAM could be used to close extended defects at the time of PE, while gracilis flaps can be used in case of VRAM complications. Gracilis flaps allow a less invasive surgery that can be performed even in complicated cases, however in weakened women, in case of a complication of the gracilis flap, it is more difficult to undergo extensive surgery such as reconstruction with VRAM (Fig. 4).

A multicenter study with a large population could be useful to assess the strict indication for reconstructive surgery and the best reconstructive technique according to the different defects.

4. Conclusion

Fortunately, several options for reconstruction surgery have been developed, and nowadays include a wide spectrum of techniques suitable for the various clinical scenarios encountered by the gynecologic oncologist. Given the continued evolution of these alternative techniques, an integrated multi-disciplinary approach in a high-volume tertiary center [47] is indicated. Consulting a plastic surgeon can help with preoperative planning as well as intraoperative decision-making.

Thus, it is imperative that the gynecologic oncologist, who is ultimately the orchestrator of these lengthy and complex extirpative procedures, knows the full spectrum of reconstructive options.

Declaration of interests

☒ The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence the work reported in this paper.

☐ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests.

CRediT authorship contribution statement

M. Arcieri: Conceptualization. **S. Restaino:** Writing – review & editing. **A. Rosati:** Writing – original draft. **R. Granese:** Supervision. **C. Martinelli:** Data curation. **A.M. Caretto:** Writing – original draft. **S. Cianci:** Methodology. **L. Driul:** Supervision. **S. Gentileschi:** Writing – review & editing. **G. Scambia:** Writing – original draft. **G. Vizzielli:** Conceptualization. **A. Ercoli:** Conceptualization, Methodology, Writing – review & editing, Validation.

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