

# Decisional Algorithms for the Reconstruction of Pelvipерineal Defects After Total Pelvic Exenteration: A Review

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## Abstract

Abdominoperineal resection remains the "gold standard" for cancers of the lower rectum and of the anal canal as a result of the failure of the primary conservative care. Total pelvic exenteration leaves an important pelvipерineal defect which requires reconstruction techniques to be applied when primary closure cannot be performed.

Pelvic floor reconstruction is required and various complications, especially infectious, may occur in this area. The pelvis can be reconstructed using flaps. The perineal reconstruction that uses the numerous perforator flaps described lately raises the following question: which flap should be chosen?

Each flap and its variants have their own advantages and disadvantages, and the choice of the appropriate reconstructive technique involves a collaboration between the gastrointestinal oncology surgeon, the radiologist, the anaesthesiologist and the plastic surgeon in order to identify when and which surgical reconstruction is to be preferred, using reconstruction algorithms to choose the appropriate technique. Various studies are presented describing the experience of one or more centers regarding reconstruction options and the decisional tree adopted in the form of an algorithm both in relation to neoadjuvant irradiation therapy and without irradiation.

## Keywords

Total pelvic exenteration; Pelvipерineal reconstruction; Algorithms; Decision tree; Flaps; VRAM; DIEP; Gluteal fold flap; Gracilis flap; Low rectal cancer; Anal canal cancer; Vulvar cancer

## Introduction

The main indicators for major perineal resection are vulvar cancer, anal cancer and low rectal cancer. Abdominoperineal resection remains the "gold standard" for the treatment of low rectal cancers and anal canal cancers due to the failure of initial conservative care.

Primary radical surgery is also indicated for anal canal tumors locally advanced at the time of initial diagnosis; curative surgery will lead to major defects in this area, requiring reconstruction. Abdominoperineal resection (total pelvic exenteration) leaves an important pelvipерineal defect and local tissue can be compromised by preoperative radiotherapy that alters tissue vascularization and delays the healing process [1]. The need for reconstruction is especially important in the pelvic area where infectious complications may occur. Primary closure was commonly applied in most patients [2]. When primary closure of perineal defects is not possible, reconstruction with skin grafts or flaps is indicated. The skin graft is suboptimal in this area because of the possible infection that results in graft destruction, delayed healing, as well as an unsatisfactory quality of scarring and contraction that may affect micturition or sexual activity.

The plastic surgeon is consulted if the oncology surgeon cannot resolve the primary defect by direct closure [2]. The pelvic floor can be reconstructed by replacing the excised tissue with flaps. Flap reconstruction has replaced the grafting technique over the last three decades. Flap reconstruction is recommended because its benefits include providing a well-vascularized healthy tissue that is able to withstand infections, increase oxygen pressure, and relieve leukocyte release in the perineal defect area, thereby reducing the complications of defect healing.

The purpose of any reconstruction is to restore function and form to achieve defect coverage with good wound healing. Successful perineal

reconstruction techniques must meet the following conditions: [3]

1. Provide enough tissue volume to fill the dead pelvic space and prevent fluid build-up.
2. Provide a skin paddle to allow perineal closure.
3. Enable rapid healing.
4. Support reconstruction of the vagina (if necessary).
5. Provide protection sensitivity.
6. Not be related to the tumour dissemination pathway.
7. Provide a reduced morbidity of the donor site.

Sheckter et al. [2] discuss the methods of closure and reconstruction, including the ideal position. It is argued that reconstruction with pedicled muscle flaps may be superior to the fasciocutaneous local flap for perineal defects. The ideal position to perform abdominoperineal resection is still discussed, but surgeons are increasingly considering ventral decubitus because recent evidence shows superior oncological results [4-7]; other authors reported reconstruction only in dorsal decubitus or lithotomy. For the ventral decubitus position, the gracilis flap is suggested.

Devulapalle et al. in a study of 566 patients [8], shows that there are few complications of flap reconstruction as compared to primary

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**Received** December 06, 2017; **Accepted** February 19, 2018; **Published** May 14, 2018

**Citation:** Moraru DC, Scripcariu V. Decisional Algorithms for the Reconstruction of Pelvipерineal Defects after Total Pelvic Exenteration: A Review. Journal of Surgery [Jurnalul de chirurgie]. 2018; 14(1): 17-22 DOI: [10.7438/1584-9341-14-1-3](https://doi.org/10.7438/1584-9341-14-1-3)

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closure. One should note that for this author flap closure includes reconstruction with VRAM and gracilis flaps. Shekter [2] also adds the V-Y flap.

Flap reconstruction after abdominoperineal resection is associated with ventral decubitus. The use of pedicled muscular flaps provides a successful solution for defects that oncologic surgeons could not perform primary closure in the past. Recent studies, as well as that of Shekter [2], recommend using the VRAM flap for abdominoperineal reconstruction in dorsal decubitus position whenever possible, as illustrated in Figure 1. The VRAM flap is superior to the gracilis flap in terms of reducing the number of complications. In the ventral decubitus position, when the VRAM flap cannot be approached, the gracilis flap is preferred to the V-Y flap (Figure 1).

In recent years, technical progress has helped reduce the morbidity associated with reconstruction [8]. The development of perforator flaps allowed the harvesting of a generous skin paddle with the underlying muscle. The collection of muscle flaps and perforator flaps provides the surgeon with additional reconstruction options. Improvements in resection techniques in general and especially in regard to the abdominoperineal cylindrical excision [8-11], with the use of laparoscopy in the first phase and abdominal perineal resection in the ventral decubitus position have led surgeons to review their reconstructive strategy. Abdominal flaps are extensively described in literature [12-14] as well as improvements in operative techniques (e.g., cylindrical excision). Perineal reconstruction using the many perforator flaps described lately raises the question: which flap should be chosen? (Table I).

Each flap and its variants have advantages and disadvantages in relation to the dissection technique, surgical history, morphology and resection procedure [12]. Choosing the reconstructive technique [12] involves collaboration between the oncologic surgeon, the oncologist, the radiologist, the radiotherapist, the anaesthesiologist and the plastic

surgeon. The choice of the donor site should take into account the existence of the medial abdominal incision, with the advantages and disadvantages of each method.

Sinna et al. used a decision tree to better illustrate their concepts. This tree is based on the following initial question: is median laparotomy necessary or not? If laparotomy is required, an abdominal flap is preferred. If surgical excision is done with the patient in ventral decubitus, gluteal and pudendal donor sites are recommended.

The authors preferred the use of the Ms-VRAM flap when the patient had an old scar on the median line, the presence of appropriate perforators and of the underlying and deep epigastric vessels. The Ms-VRAM is quickly and easily harvested as compared to the DIEP flap and avoids the sequelae of the abdominal wall associated to the conventional VRAM flap due to the presence of muscle and residual fascia in sufficient quantity for closure. Bringing a DIEP pedicled flap into the cavity is synonymous with a transfixion of the rectus abdominis muscle. When abdominal incision is unnecessary, when cylindrical abdominoperineal excision is performed in ventral decubitus, the authors prefer the use of the gluteal donor site and especially the flaps based on the internal pudendal artery. This flap is not recommended in patients with radiotherapy history. In the absence of perforator vessels (undetected or destroyed during the intervention), IGAP and IGAM flaps, that provide sufficient volume, will be used. The gracilis flap is indicated when the pedicle (explored during preoperative imaging) is very close to the pubic symphysis (7 cm) and when a medium volume for reconstruction is needed. Choosing an appropriate reconstruction technique is in line with the imperatives of surgical excision.

Sinna R et al. [15] elaborates an algorithm for the reconstructive technique of choice that depends on the initial situation: amputation in the position of dorsal decubitus, cylindrical amputation in ventral decubitus or secondary perineal sinus (Figure 2).

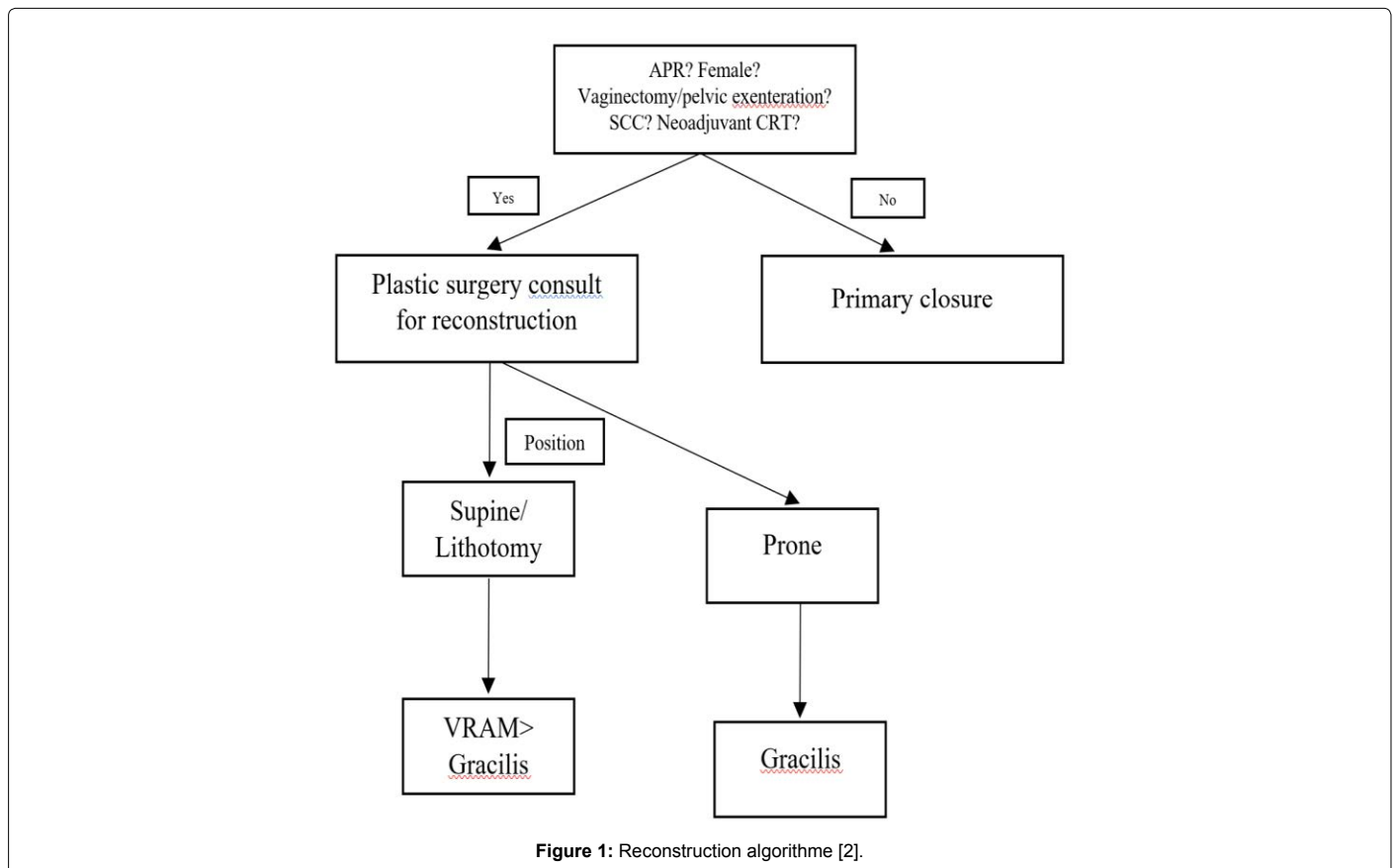


Figure 1: Reconstruction algorithm [2].

Table I: Pelvi-perineal flap reconstruction options.

Pelvi-perineal flap reconstruction		
Donor site	Advantages	Disadvantages
1. Abdominal flaps VRAM Ms-VRAM Fs-VRAM DIEP	Single operatory position Reliability Volume Laparotomy present-no additional donor site required	DIEP: muscle transaction limits the flap advantages VRAM: importance of abdominal sequelae Stoma next to the incision deformation Deformation of the abdominal wall
2. Gluteal flaps SGAP IGAP IGAM	Avoid abdominal incision Uni or bilateral Adapted for cylindrical abdominoperineal excision Same position	Preoperative imaging Radiation area Limited rotation
3. Pudendal flaps Pudendal flap Gluteal fold flap (GFF) Lotus flap Singapore flap	Same advantages as Gluteal flaps Residual scar in gluteal sulcus	Preoperative imaging Radiation area Limited rotation
4. Gracilis flap	Non irradiated area Minimal functional sequelae	Small volume Inconstancy of distal skin paddle
5. Posterior thigh flap	Non irradiated area Preserved sensitivity	"Stocking seam" donor site scar Small volume

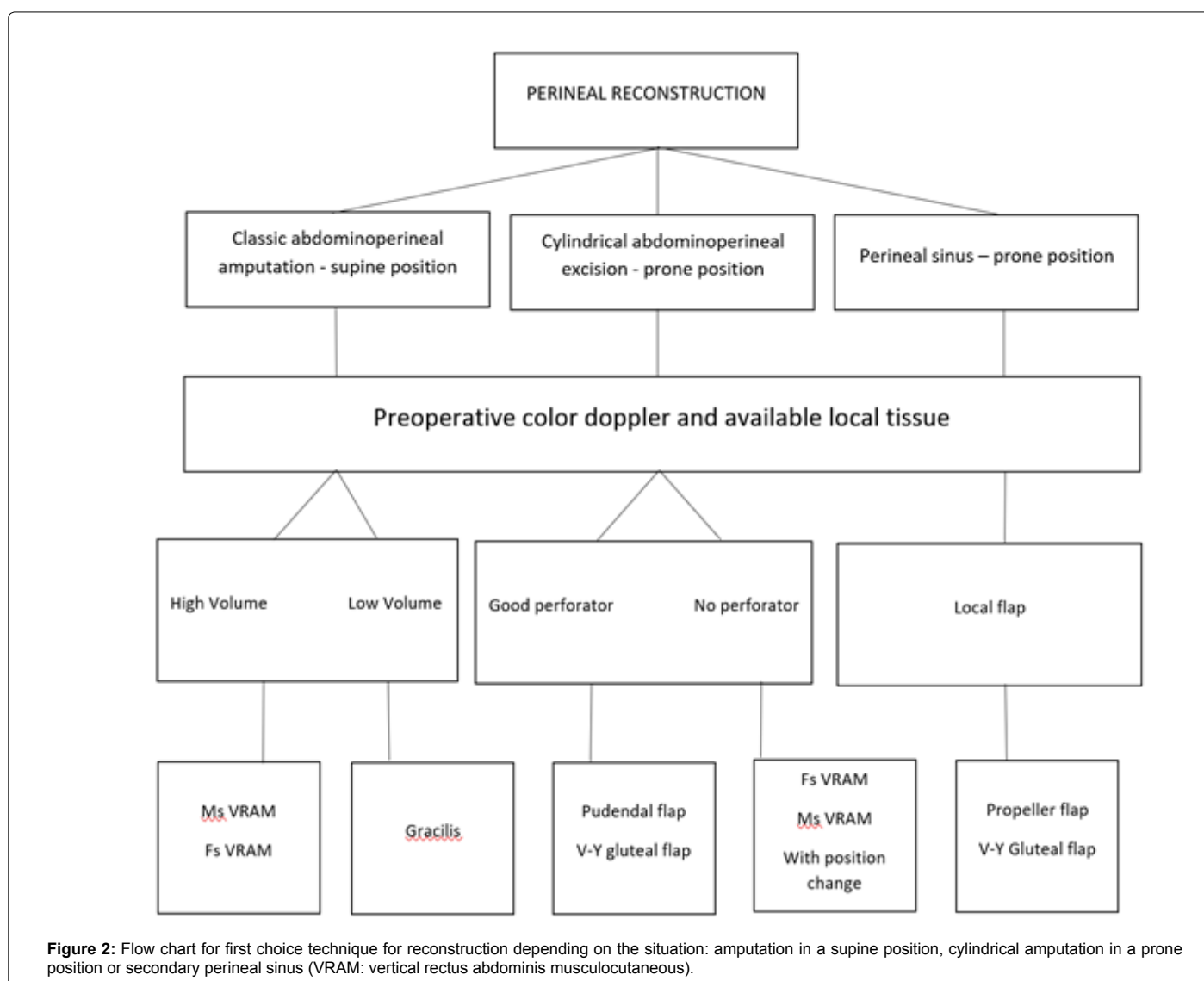


Figure 2: Flow chart for first choice technique for reconstruction depending on the situation: amputation in a supine position, cylindrical amputation in a prone position or secondary perineal sinus (VRAM: vertical rectus abdominis musculocutaneous).

If the excision is performed in the ventral decubitus position, perforator flaps from the gluteal or pudendal regions are preferred. If laparotomy is planned, the Ms-VRAM flap is recommended as it allows rapid and safe reconstruction with few sequelae. If the gluteal or thigh flaps are chosen, consideration will be given to the patient's gender,

defect volume and radiotherapy history. A preoperative imaging study is required to provide the surgeon with good information about the flap selection. Factors influencing the choice of the donor site for the flap are as follows: supination position, laparotomy, ventral decubitus, and radiation history [8] (Table II). These reconstruction options

Table II: Pelvi-perineal reconstruction decision factors.

Pelvi-perineal reconstruction decision factors				
Donor site	Supine position	Laparotomy	Prone position CAE	Irradiation
Abdominal flaps	++	+++	0	+++
Gluteal flaps	0	0	+++	+
Pudendal flaps	+	0	+++	+
Gracilis flap	+++	0	0	+++
Posterior thigh flap	0	0	++	+++

CAE: Cylindrical abdominoperineal excision;  
0: Non indicated  
+: Possible  
++: Interesting  
+++: Recommended

can easily be accomplished by the oncological surgeon without the intervention of plastic surgeons, allowing more freedom in the care of these patients. John HE et al. [16] presents an algorithm for perineal reconstruction after cancer resection based on the experience of two international centres. The plastic surgeon is faced with the growing challenges of perineal reconstruction after extensive local excision, malignancies that appear in the anal canal, rectum, vulva and vagina (Table II and Figure 2).

With all advances in neoadjuvant therapy for perineal malignancies, surgical resection of the tumour remains the treatment of choice. Adverse conditions such as advanced local disease (often recurrent), previous surgery and tissue irradiation, often associated, make surgical care difficult. The surgeon is faced with a large defect when primary closure cannot be achieved. Over time, many perineal reconstruction techniques have been developed to reduce morbidity by limiting the volume of the resected tissue, and providing a satisfactory aesthetically pleasing tissue with restoration of the function.

Reconstruction options range from local advancement flaps for smaller defects to pedicled flaps harvested from the inner thigh region, the gluteal fold and the abdomen for large defects. Methods have evolved from the skin graft to varied flaps such as musculocutaneous gracilis, fasciocutaneous gluteal and the more commonly used at present, the abdominal muscular flap [17,18]. Each procedure is accompanied by a set of complications and the surgeon has to use the appropriate technique for the case. John et al. recommends a guideline for time-tested techniques used for perineal reconstruction, based on the place of malignancy and the magnitude of the primary defect. Defects are classified as small (<20 cm<sup>2</sup>), medium (20-60 cm<sup>2</sup>) and large (>60 cm<sup>2</sup>).

An algorithm is proposed for the reconstruction of perineal defects after resection of vulvar, vaginal, anal or rectal malignancies, with or without pelvic exenteration. We will refer to perineal defects as a result of the resection of anorectal malignancies. If the defect following abdominoperineal resection is large (over 60 cm<sup>2</sup>) or associated with pelvic exenteration, the rectus abdominis muscle flap is recommended; in the case of medium defects (below 60 cm<sup>2</sup>) or large defects but without pelvic exenteration, the gluteal or the pedicled gracilis flap is recommended (Figure 3).

RAM flap (Rectus Abdominis Muscle Flap) is the most commonly used option in reconstructive surgery after abdominoperineal resection with or without exenteration. Nelson and Butler [13] compare 133 patients who underwent exenteration surgery following abdominoperineal resection and found that RAM flaps developed a significantly lower rate of complications as compared to various thigh flaps. Another current option for perineal reconstruction is the gluteal flap. Its disadvantage is the discomfort of the patient in the sitting position during the postoperative period. It is recommended that patients do not take this stance for more than a few minutes in the first three weeks, thus affecting the quality of life.

Winterton et al. [19] make a series of references on reconstructive surgery after abdominoperineal resection. Recent trends towards more radical excision surgery, especially for tumour recurrence after 20 years of initial radiotherapy, led to an increase in defect size, especially in the perineum area. These defects are undergoing reconstructive surgery since the primary closure of the perineal cavity is often unsatisfactory [3].

Perineal defects are created during gynaecological, urological and colorectal ablative procedures. Pelvic and perineal defects after these interventions often leave a large cavity that cannot be primarily closed, with functional deficits in both men and women [19]. The use of flaps has led to a variety of available solutions, which include: fasciocutaneous, musculocutaneous, muscular and omental flaps or a combination of these.

Until recently, the standard procedure of first intent for primary reconstruction was a muscular or musculocutaneous flap, the most commonly used muscles being Rectus Abdominis, Gracilis or Gluteus Maximus. Lately, the gluteal flap is a reliable form of reconstruction. The fasciocutaneous gluteal flap is a multilateral option for the reconstruction of a wide range of pelvic and perineal defects. Patients with multiple co-morbidities, radiotherapy cases, and cases where the anus has been resected will need a longer time for healing.

Winterton et al. [19] presents an algorithm for the care of perineal defects after tumour resection; the authors believe that all but the very large defects can be reconstructed with the gluteal flap. If the pelvic exenteration is anticipated, the VRAM flap is recommended, and for all other defects, the authors find plenty of soft tissue and epithelium that can be harvested by suggesting the gluteal flap. They believe that the gluteal flap can be considered a first choice for many vulvar, vaginal and perineal defects, and in this aspect present an algorithm for choosing this flap.

The algorithm mentions the reconstructive methods that can be chosen, showing that the most important factor to be considered is whether the patient has an indication for the surgical treatment of his tumour, whether or not he or she will undergo total pelvic exenteration and which is the extent of the defect after resection. The decision to use the type of rotation or advancement flap remains the surgeon's choice, intra-operatively.

If the patient is subjected to total pelvic exenteration, the VRAM flap is indicated. If the resection is lower, then for men undergoing perineal and anal resection, unilateral or bilateral gluteal flaps are recommended, rotation or advancement ones. In case of subtotal exenteration, the profound or superficial composite gluteal flap is recommended.

For women, if resection is reduced in various situations such as vulvectomy, partial vulvectomy, or vaginectomy, the unilateral or bilateral, rotation or advancement gluteal flap is recommended; in case

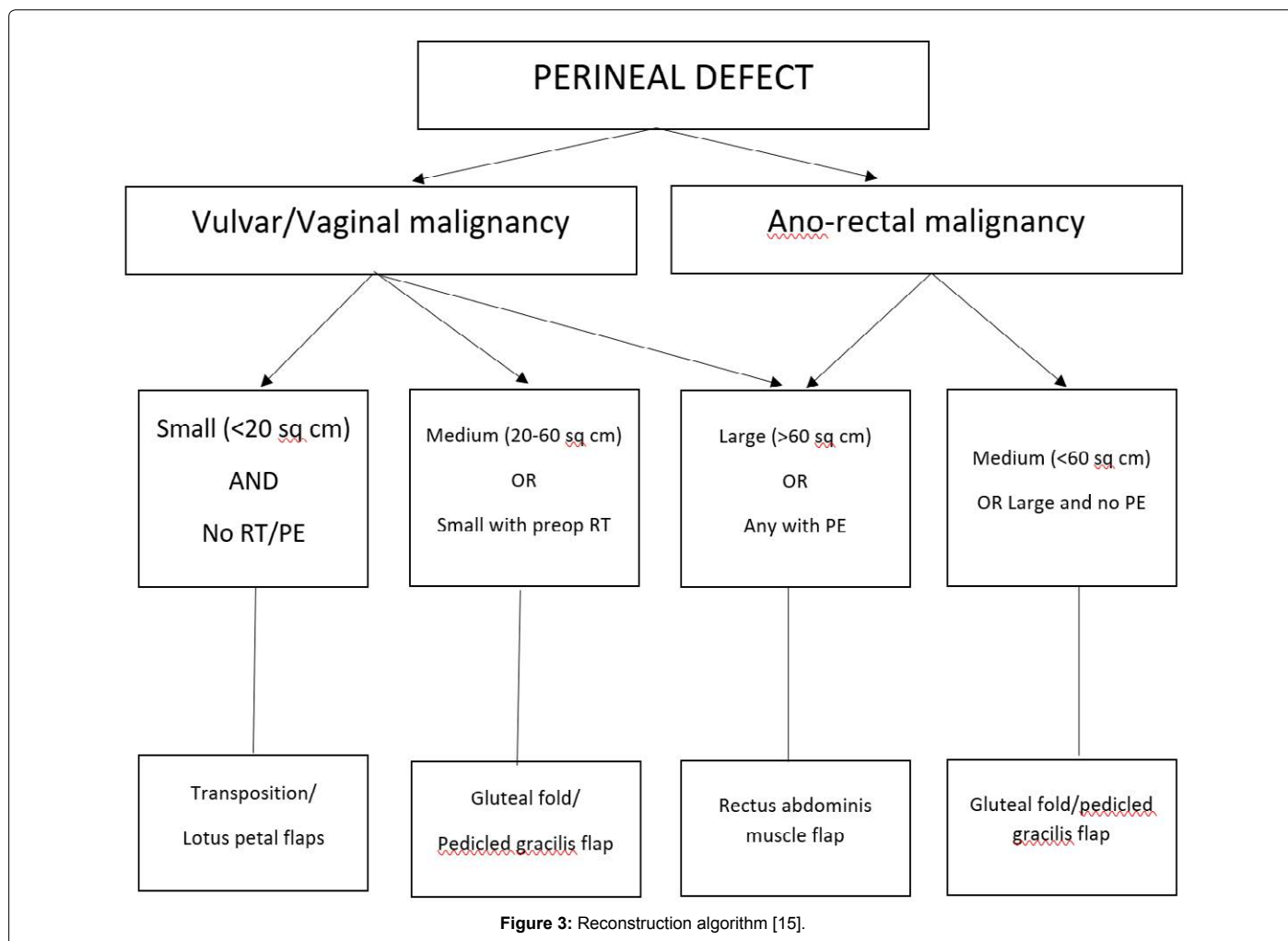


Figure 3: Reconstruction algorithm [15].

of partial or total vulvectomy, vaginectomy, anus resection as well as subtotal exenteration, the deep or superficial composite gluteal flap is recommended.

According to this algorithm, it is considered reasonable that the gluteal flap should be used as the primary intention choice for many vulvar, vaginal and perianal defects. For the reconstruction of the irradiated perineum after abdominoperineal excision, Saleh DB et al. [20] suggest an algorithm with the use of the new approaches for these defects. The closure of the perineal cavity due to abdominal-perineal excision of the rectum (APER) continues to be a challenge for oncologist and reconstructive surgeons.

Current oncological treatment has evolved to an extensive rectal abdominal-perineal excision (eAPER) in an attempt to reduce the recurrence rate and prolong survival. Recently, there is a focus on switching options from direct closure to complex reconstruction techniques in order to avoid extended hospitalization, discomfort, and repeated surgical interventions that occurred in the case of direct cavity closure, especially before the introduction of eAPER and the frequent use of perineal neoadjuvant irradiation. The new flap reconstruction methods of the irradiated perineum are presented for surgical practice in the form of an algorithm in order to achieve the best possible evolution [20].

Saleh et al. [20] considers flap reconstruction in patients irradiated after eAPER to be superior to direct closure and/or locking with meshes to prevent perineal hernias. He believes that there are many advantages by closing all skin defects with Z-plasty and using the uterus as a means of reconstruction where necessary.

Aggressive surgery and neoadjuvant therapy for primary, recurrent rectal and anal tumors has a high rate of healing. In patients receiving neoadjuvant radiotherapy or chemotherapy for these tumours, a slower healing of the defect is possible [12,21]. Numerous techniques are included in the literature including local flap reconstruction, muscle flaps, fasciocutaneous flaps or omental flaps. Compared with direct closure, muscle flaps give rise to less complications of the perineal defect.

The VRAM (Vertical Rectus Abdominis Flap) and the gluteal flap on upper and lower artery perforator (SGAP and IGAP), and pudendal thigh flap (PTF) are used, each with its advantages and disadvantages. For rectal abdominoperineal excision (APER) after radiotherapy, reconstruction with both VRAM and gracilis flap is recommended. The VRAM flap is predominantly used for the pelvic exenteration defects as well as when the anorectal excision is not performed laparoscopically but by laparotomy. Single or double Z-plasty of the perineal skin removes the need for a skin paddle, providing a safe, non-irradiated skin intake with sufficient volume to optimize the chances of successful healing without abnormal perineal contours (encountered in the use of cutaneous paddle flaps) [20].

These reconstructive techniques reduce the morbidity associated with the irradiated perineal defect. The techniques discussed have certain indications in perineal closure and are dependent on the surgical approach to excision. Flap closure, combined with the Z-plasty of the skin, captures the dead space, removes the need for skin intake, thus providing a non-irradiated skin for the defect.

## Conclusion

The existence of the numerous flaps described in literature raises the question of choosing the flap appropriate to each situation. It is necessary to evaluate the advantages and disadvantages of each flap depending on the surgical situation, so that finally an algorithmic decision tree could be followed.

## Conflict of Interest

The authors have no conflict of interest to disclose.

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