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Groin defect reconstruction with perforator flaps: Considerations after a retrospective single-center analysis of 54 consecutive cases

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Summary *Introduction:* Groin defects with exposed complex structures are challenging to treat. Perforator flaps provide a contemporary alternative to established muscle flaps to cover all varieties of groin defects, with minimum donor site morbidity, less postoperative pain, and faster rehabilitation. In this retrospective single-center analysis, we aimed to show that pedicled perforator flaps are a valid option for groin defect reconstruction. We present three different pedicled perforator flaps and discuss the flap selection process and their distinct advantages and disadvantages.
Methods: A series of 54 consecutive cases of patients with groin defects were allocated into three different treatment groups. Reconstruction was performed utilizing the anterolateral thigh (ALT) flap, the pedicled posteromedial thigh (PMT) perforator flap, and the vertical deep inferior epigastric artery perforator (vDIEP) flap.
Results: All 54 flaps survived. Early complications included one hematoma (vDIEP) and two infections (ALT and PMT). Delayed complications occurred in three recipient-site seromas (ALT, PMT, and vDIEP), one donor-site seroma (vDIEP), and one flap dehiscence (ALT). All flaps provided stable coverage during 3–12 months of follow-up.

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Conclusion: We propose pedicled perforator flaps to be a safe and reliable option for groin defect reconstruction. The pedicled PMT flap should be the first choice if the profunda femoris artery and its perforators are available. The ALT flap can be applied as a second choice, especially if complex groin defect with exposed vascular prosthesis reconstruction is needed because of its versatile expansion options, for example, as a chimeric flap using a portion of the vastus lateralis muscle. In cases where the profunda femoris artery is not available, the vDIEP flap should be the preferred method.

Introduction

Defects of the groin region with exposed structures such as femoral vessels or foreign material-like vascular prosthesis cause a demanding field in reconstructive surgery.

Various surgical reconstructive strategies have been described. Traditionally, pedicled muscle flaps or myocutaneous flaps were used to provide a safe and well-vascularized coverage of these wounds. The gracilis, sartorius, rectus femoris (RF), tensor fascia lata, and rectus abdominis muscle flaps have become successful workhorses owing to their constant anatomy, ease of harvest, and vicinity to the defect.[1–5]

However, because of advancements in microvascular techniques, this approach was revolutionized as the concept of perforator flap was introduced. In the recent past, Wei and Mardini introduced the concept of perforator flaps, which opened the possibility to acquire new local reconstructive options for the groin with less donor site morbidity.[6,7] Experience with perforator flaps thus far has revealed satisfying advantages for various indications. Donor site morbidity was reduced to the minimum owing to advanced perforator flap techniques that enable the harvest of tissue without injuring the underlying muscle. Furthermore, neither main vessels nor nerves must be sacrificed. Additionally, patients have shown accelerated rehabilitation, decreased hospitalization times, and less postoperative pain.[8]

CT angiography has become an important instrument to easily depict the course, size, exact location, and number of perforators of targeted body areas. Preoperative planning based on CT angiography results is important for the selection of the perforating artery, which shortens operative times and decreases patient morbidity.[9]

In this study, we aimed to show that pedicled perforator flaps are a valid and reliable contemporary option in groin reconstruction.

This retrospective single-center analysis presents a series of 54 consecutive cases of pedicled perforator flaps used for groin defect reconstruction. Three different local surgical options are presented, and their distinct characteristics, indications, advantages, and limitations are discussed.

Patients and methods

Between 2014 and 2018, 54 consecutive patients with groin defects from one center requiring plastic reconstruction were included for this study. Demographic data including sex, age, injured side, most relevant comorbidities, and flap characteristics were collected and are summarized in Table 1.

The patients were allocated into three different treatment groups depending on the kind of flap used for the reconstruction. All surgical procedures were performed by the same surgeon.

Three types of flaps were used for the groin coverage: the anterolateral thigh (ALT) flap in 20 patients, the posteromedial thigh (PMT) perforator flap in 18 patients, and the vertical deep inferior epigastric artery perforator (vDIEP) flap in 16 patients. The best suitable flap was chosen according to clinical criteria including localization, comorbidities, and the individual patient's anatomy and characteristics (e.g., pre-existing scars). Furthermore, every patient underwent preoperative CT angiography to facilitate flap choice and reconstruction planning. We created a concise algorithm guiding through our flap election process (Figure 7), and additionally, Figure 8 provides a schematic presentation of our flap selection.

The harvesting technique of the ALT, PMT, and vDIEP flaps has been well described elsewhere, and we refer the reader to previously published papers.[22,10–12] The ALT flap was tunneled under the RF muscle, preserving the dominant RF-branch in all cases, to minimize the risk for muscle necrosis. In our experience, minding the RF branch did not preclude a tension-free coverage of the defect at the groin and did not cause hazardous kinking of the pedicle. We observed no cases of flow disturbances due to kinking or compression of the pedicle.

In patients undergoing reconstruction with the PMT, tunneling the flap under the muscle bellies of the gracilis muscle and adductor longus muscle was necessary to reach the recipient site.

Generous undermining in the suprafascial plane over the inguinal ligament was carried out to allow flap transfer in patients reconstructed with vDIEP. Furthermore, thorough preparation of the recipient site was performed, including extensive debridement of all non-vital tissue. Partial de-epithelization of the flap was carried out in some patients to achieve obliteration of optimal dead spaces.

Our standardized postoperative procedure included drains to be removed after 5 days and discharge from hospital within 7 days. Follow-up was 3 to 12 months. Postoperative surgical site morbidity was evaluated. Therefore, early (occurring within 30 days after surgery) and delayed (occurring later than 30 days after surgery) postoperative complications were distinguished.

Table 1 Characteristics of patients and flaps.

	Patient	Gender	Age	Cause of groin defect	Comorbidities	Flap	PFA intact (yes/no)	Source vessels	Complications
Group ALT	1	M	58	Infection following primary closure after tumor resection	DM, HTN,	ALT	Yes	dLCF	None
	2	M	61	Infected wound after groin dissection	None	ALT	Yes	dLCF	None
	3	M	47	Infected wound after ECMO	CABG, DM, Smoking	Chimeric ALT	Yes	dLCF	None
	4	M	54	Infected wound after ECMO	CABG, PVD, DM	Chimeric ALT	Yes	dLCF	None
	5	M	60	Infected wound after F-P bypass	HTN, PVD, CAD	Chimeric ALT	Yes	Dlcf	None
	6	F	56	Infection following primary closure after tumor resection	None	ALT	Yes	dLCF	Recipient-site seroma
	7	F	61	Infected wound after ECMO	PVD, CABG	ALT	Yes	dLCF	None
	8	M	79	Infected wound after ECMO	DM, CABG	ALT	Yes	dLCF	None
	9	F	40	Infection following primary closure after tumor resection	None	ALT	Yes	dLCF	None
	10	M	57	Infected wound after F-P bypass	PVD, HTN	Chimeric ALT	Yes	dLCF	Infection
	11	M	36	Infected wound after SLN biopsy	None	ALT	Yes	dLCF	None
	12	M	48	Infected wound after groin dissection	DM	ALT	Yes	dLCF	None
	13	M	65	Infected wound after F-P bypass	CABG, PVD	Chimeric ALT	Yes	dLCF	None
	14	F	43	Infection following primary closure after tumor resection	None	ALT	Yes	dLCF	None
	15	M	50	Infection following primary closure after tumor resection	DM	ALT	Yes	dLCF	None
	16	M	35	Infected wound after SLN biopsy		ALT	Yes	dLCF	Flap dehiscence
	17	M	49	Infected wound after F-P bypass	PVD, DM	Chimeric ALT	Yes	dLCF	None
	18	M	56	Tumor resection (MM)	None	ALT	Yes	dLCF	None
	19	F	70	Infected wound after groin dissection	DM	ALT	Yes	dLCF	None
	20	F	62	Tumor resection (MM)	HTN	ALT	Yes	dLCF	None
Group PMT	1	M	78	Tumor resection (MM)	None	PMT	Yes	PFA	None
	2	M	30	Trauma	Smoking	PMT	Yes	PFA	None
	3	M	65	Infected wound after F-P bypass	HTN, DM, PVD	PMT	Yes	MCFA	None
	4	F	68	Infected wound after F-P bypass	HTN, DM, PVD, CAD	PMT	Yes	PFA	None
	5	F	71	Infected wound after ECMO	CABG, DM	PMT	Yes	PFA	None
	6	F	69	Infected wound after ECMO	CABG, HTN, PVD	PMT	Yes	PFA	None

(*continued on next page*)

Table 1 (*continued*)

	Patient	Gender	Age	Cause of groin defect	Comorbidities	Flap	PFA intact (yes/no)	Source vessels	Complications
	7	M	36	Infected wound after groin dissection	None	PMT	Yes	PFA	None
	8	M	58	Infection following primary closure after tumor resection	DM	PMT	Yes	PFA	None
	9	M	66	Infected wound after groin dissection	None	PMT	Yes	MCFA	None
	10	M	40	Trauma	None	PMT	Yes	PFA	None
	11	M	64	Infected wound after groin dissection	CABG, DM	PMT	Yes	PFA	None
	12	M	49	Infection following primary closure after tumor resection	None	PMT	Yes	PFA	None
	13	M	57	Infected wound after groin dissection	DM, HTN	PMT	Yes	PFA	Recipient-site seroma
	14	M	45	Tumor resection (MM)	None	PMT	Yes	PFA	None
	15	M	74	Infected wound after ECMO	CABG, PVD	PMT	Yes	PFA	None
	16	F	42	Infected wound after groin dissection	None	PMT	Yes	PFA	Infection
	17	M	68	Infection following primary closure after tumor resection	DM	PMT	Yes	PFA	None
	18	M	57	Tumor resection (MM)	Smoking	PMT	Yes	PFA	None
Group vDIEP	1	F	43	Infected wound after F-P bypass	DM, HTN, PVD	vDIEP	No	DIEA	None
	2	M	68	Infected wound after F-P bypass	Smoking, HTN, PVD	vDIEP	No	DIEA	None
	3	M	50	Sarcoma	DM, HTN	vDIEP	No	DIEA	None
	4	M	35	Sarcoma	Smoking	vDIEP	No	DIEA	None
	5	F	79	Infected wound after F-P bypass	PVD, DM	vDIEP	No	DIEA	None
	6	F	76	Infected wound after F-P bypass	PVD	vDIEP	No	DIEA	Hematoma
	7	M	58	Infected wound after F-P bypass	Smoking, PVD	vDIEP	No	DIEA	None
	8	M	56	Tumor resection (MM)	Smoking, HTN	vDIEP	No	DIEA	Donor-site seroma
	9	M	44	Tumor resection (MM)	None	vDIEP	No	DIEA	None
	10	M	51	Sarcoma	DM	vDIEP	No	DIEA	Recipient-site seroma
	11	M	43	Tumor resection (MM)	None	vDIEP	No	DIEA	None
	12	M	78	Infected wound after F-P bypass	PVD, DM	vDIEP	No	DIEA	None
	13	M	66	Infected wound after F-P bypass	PVD, Smoking	vDIEP	No	DIEA	None
	14	M	47	Trauma	Smoking	vDIEP	No	DIEA	None
	15	M	59	Tumor resection (MM)	None	vDIEP	No	DIEA	None
	16	M	71	Infected wound after F-P bypass	PVD, CABG	vDIEP	No	DIEA	None

DM: diabetes mellitus; PVD: peripheral vascular disease; HTN: Hypertension; CABG: coronary artery bypass graft; CAD: coronary artery disease; F-P: femoral-popliteal; PFA: profunda femoris artery; MCFA: medial circumflex femoral artery; MM: malignant melanoma.

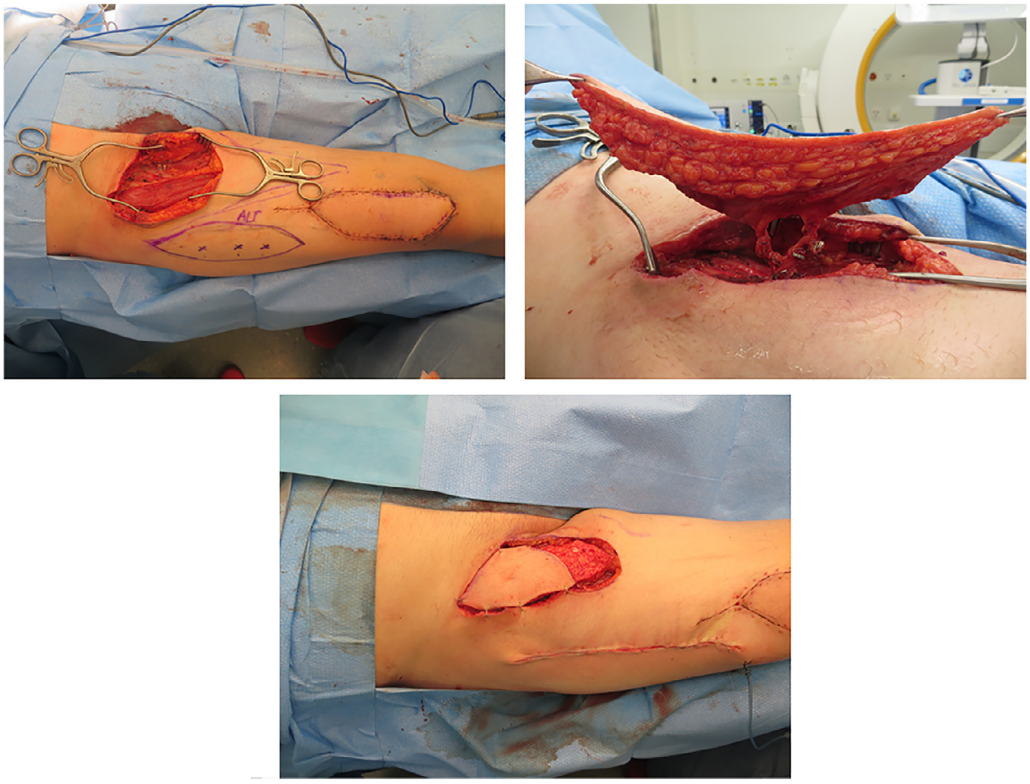

Figure 1 Radical groin lymph node dissection resulted in a deep defect with exposed inguinal vessels in a 56-year-old patient who has previously undergone melanoma excision of the right knee and reconstruction with a lower medial thigh (LMT) propeller flap. A 16 × 8 cm pedicled ALT flap from the ipsilateral thigh was planned (above left). The flap was harvested based on two perforators (above right), tunneled under the RF muscle, and partially de-epithelized to better obliterate the dead space of the distal wound (below).

Results

Thirteen women and 41 men with an average age of 56 years (range: 30–79 years) were treated. Seventeen of the 54 patients were healthy with no known risk factors for flap reconstruction. The remaining 37 presented at least one risk factor, ranging from smoking or simple hypertension to diabetes mellitus or arterial disease (see Table 1). Cause of the groin soft tissue defects included infection ($n = 39$), excision of cancer ($n = 12$), and trauma ($n = 3$). In the ALT group, in 6 cases, a chimeric ALT with vastus lateralis muscle flap (VLM) was used to cover large soft tissue defects with exposed femoral vessels and synthetic graft exposure. The remaining 14 ALT flaps, as well as all the 18 PMT flaps and the 16 vDIEP flaps, were fasciocutaneous island flaps, designed to sufficiently fulfill the case-specific requirements.

Three early postoperative complications were recorded: in the vDIEP group, one hematoma occurred in a patient who had an infected wound after vascular reconstruction requiring therapeutic anticoagulation; two recipient site infections in the ALT and PMT groups, respectively, underwent further surgical debridement and delayed primary closure.

Five delayed postoperative complications were reported: three recipient site seromas in the ALT, PMT, and vDIEP groups, respectively, and one donor site seroma in the vDIEP group, which resolved spontaneously. Moreover, one flap dehiscence in the ALT group was recorded and treated conservatively.

All the flaps provided stable coverage.

- Group ALT

Although 6 of 20 reconstructions were complex with exposed vascular prosthesis material and the use of a chimeric ALT with a portion of vastus lateralis muscle (VLM) was required, no functional problems occurred. Primary closure could be achieved in all cases, no skin grafts were necessary, and the cosmetic result was acceptable. In addition to cases in which a muscular component was deemed necessary to achieve an adequate filling of the defect (i.e., requiring a chimeric flap), the ALT region was also chosen as a donor site in cases where no sizeable perforators for the PMT flap were identified at the preoperative CTA (Figures 1 and 2).

- Group PMT

All groin defects covered with PMT flaps healed uneventfully. No postoperative donor site complications were present in our series, and donor site morbidity was minimal. Patients reported considerable satisfaction about the well-hidden scar (Figures 3 and 4).

Figure 2 Immediate postoperative picture (left); follow-up at 6 months (right).

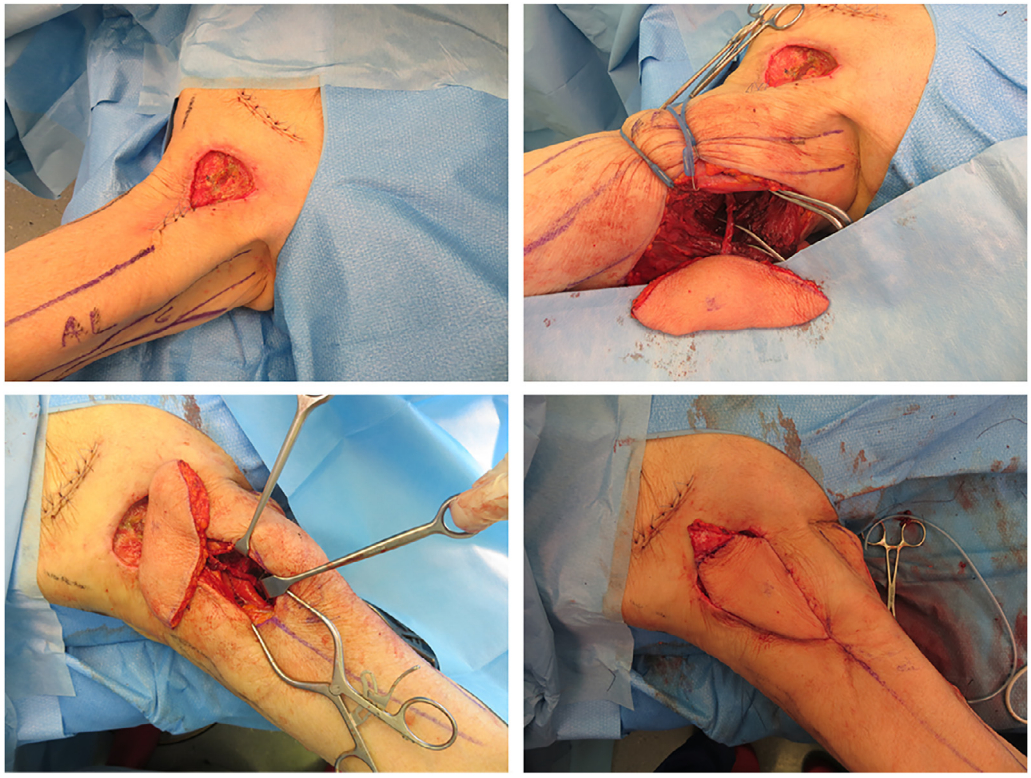

Figure 3 A pedicled PMT flap was planned to cover an 8 × 5 cm groin defect with exposed bypass grafting material in this 68-year-old patient (above left). The flap was harvested and tunneled under the gracilis and adductor longus muscle (above right and below left), the proximal part of the PMT flap was de-epithelized for dead space obliteration (below right).

- Group vDIEP

Groin reconstruction using vDIEP was successful in all 16 cases. Long-term complications of the donor site, such as abdominal wall hernia or bulging, did not occur in our series (Figures 5 and 6).

Discussion

Here, we present three options of pedicled perforator flaps for complex groin defect coverage with a case series of 20, 18, and 16 patients for each of the ALT, PMT, and vDIEP flaps, respectively.

Owing to the extensive experience with the free PMT flap for breast, head and neck, and lower limb soft tissue defect reconstructions, the authors previously described the PMT flap in its pedicled form and currently investigated its application for groin defect reconstruction.[10,13–16]

In terms of flap survival rate (100%) and early complication rate (mean: 5.5%), no differences were observed. However, the availability of the source vessel and perforator selection are critical to decide which pedicled perforator flap can be performed. The ALT flap is based on perforators of the descending branch of lateral circumflex femoral artery (LCFA), which is a proximal branch of the profunda femoris artery (PFA). The pedicled PMT flap is based on perforators

Figure 4 Immediate postoperative picture (left); follow-up at 6 months (right).

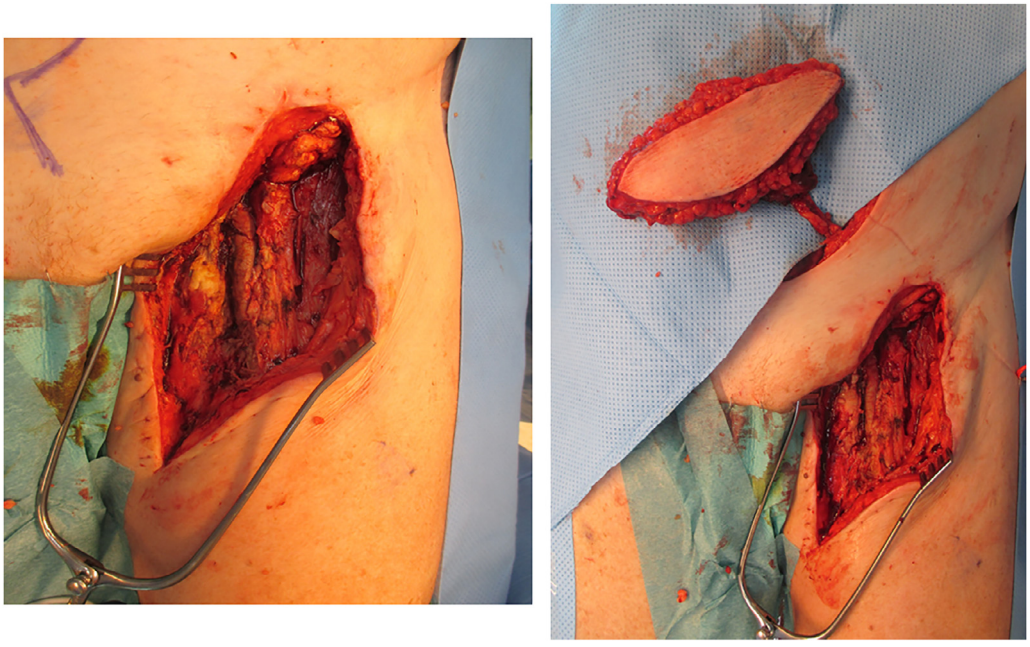

Figure 5 A 12 × 6 cm groin defect deriving from a complicated femoral-popliteal by-pass surgery in a 79-year-old patient (left). Complete stenosis of the PFA prevented the use of a pPMT or ALT flap; for this reason, a vDIEP was harvested (right).

that are directly arising from the PFA or MCFA. The vDIEP flap is based on perforators of the deep inferior epigastric artery. Manjappa et al. studied the anatomy of the PFA and found that this main vessel might be absent in 5% of the population.[17] In addition, the PFA might be obstructed owing to diverse angiopathies or is missing due to ligation in previous surgeries. In those cases, the deep inferior epigastric vessels provide an alternative, and a pedicled vDIEP flap is the option of choice.

Currently, the pedicled ALT flap represents the most popular flap for the coverage of difficult wounds of the groin region because of its favorable location, constant anatomy, long pedicle, and low donor site morbidity.[18–20] In addition to its various advantages, the versatility of this flap is excellent: it easily allows extension of the skin paddle and it can also be harvested as a compound or chimeric musculocutaneous flap, including a portion of VLM, which can be extremely useful when an extra-bulk is required to fill deep

Figure 6 Immediate postoperative picture (left); follow-up at 6 months (right).

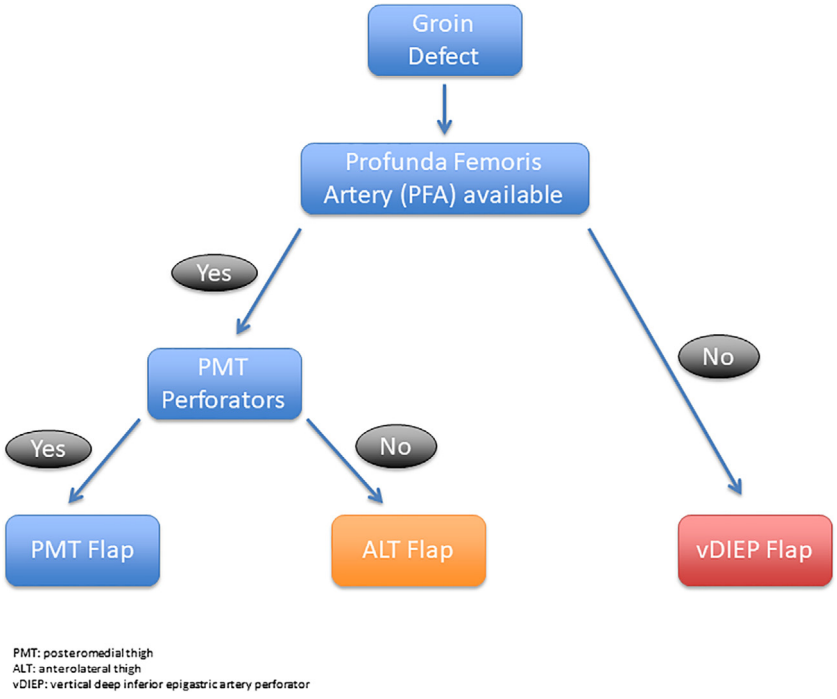

Figure 7 Schematic presentation of our selection algorithm for groin defect reconstruction.

wounds.[21,22] Moreover, a sensitive version of the fasciocutaneous pedicled ALT has been recently described by including the lateral femoral cutaneous nerve within the flap, which is thought to provide protective sensation of the groin if necessary.[23]

Zeng et al. described a new application of the pedicled deep inferior perforator (DIEP) flap for scrotal and groin defect repair. They used eight pedicled DIEP flaps and covered five penoscrotal and three groin defects. No complications occurred; therefore, the authors concluded that this flap is an alternative option for complex groin defect.[24]

We confirm the conclusion of Zeng et al., although donor site morbidity and scarring are superior for the PMT and ALT flap, rendering them preferable to the DIEP. Although we

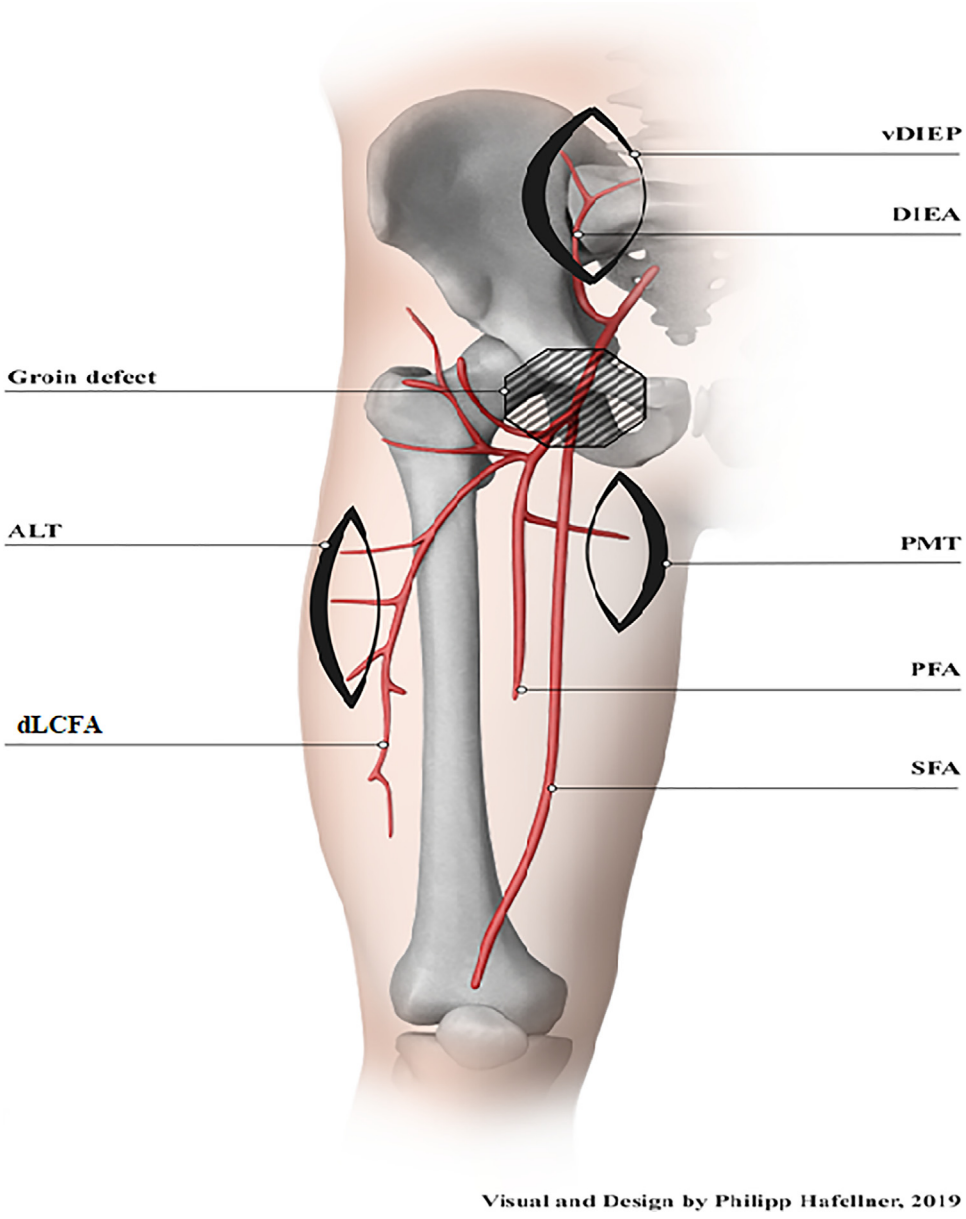

Figure 8 Schematic presentation of pedicled perforator flaps in positional relationship to the groin. PFA: profunda femoris artery, SFA: superficial femoral artery, DIEA: deep inferior epigastric artery, dLCFA: descending LCFA.

did not observe any donor site morbidity in our vDIEP group, long-term impact on the abdominal wall stability was not investigated.

Miyamoto et al. reported three successful cases of groin reconstruction with the utilization of superficial femoral artery perforator (S-FAP) flap;[25] however, this option is not always available owing to the extent of the previous operation or trauma, which could have injured the perforators.

In our experience, we propose the pedicled PMT flap as the perforator flap of first choice for groin defects if PFA is available, and the defect can be filled and covered sufficiently. The key advantages of this method are low donor-site morbidity and well-hidden scar. The ALT flap should be applied as the second choice or if a complex groin defect reconstruction is essential. This flap with its pronounced variability provides various chimeric design possibilities as mentioned above in this article. In cases where the PFA is not available, vDIEP flap is the preferred method for the reconstruction of a groin defect (Figures 7 and 8).

There is still no clear evidence about the ability of different types of tissues to clear bacterial infection among scientific community, but there remains a strong belief in the potential of the muscular tissue compared to that of the fasciocutaneous tissue.[26] The main cause of groin defects in our present case series was an infection in 72% of patients equally distributed in all three treatment groups. We observed a faultless healing of all these defects covered with a fasciocutaneous flap and, therefore, conclude

that pedicled fasciocutaneous flaps are safe and reliable as a first-line option for groin defect reconstruction independent of the cause.

Muscle flaps remain a solid alternative and represent still the technique of choice when the expertise in perforator flap surgery is not available at the treating hospital. When using muscle flaps, the gracilis muscle flap should be preferred owing to its acceptable donor site morbidity and well-hidden scar.[2] Particularly, the rectus abdominis muscle flap should be very limited in use because of significant donor site morbidity.[1]

Conclusions

In contemporary reconstructive surgery with the use of advanced microvascular knowledge and techniques, groin defects can be safely addressed with local perforator flaps. According to our experience, the availability of the PFA and the degree of complexity of the defect are the main factors guiding the selection of the perforator flap. The favorable donor site makes the PMT flap our preferred option, followed by the ALT flap. The use of vDIEP flap should be restricted to those patients in whom the vascular supply to PMT and ALT is damaged or questionable. Muscle flaps are still a reasonable treatment option for groin defects but should be considered as a second-line treatment in cases where perforator flaps are not feasible.

Disclosure

The authors have no financial conflicts or commercial associations to disclose.

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