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The Role of Muscle Flaps for Salvage of Failed Perforator Free Flaps

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Background: Despite the most heroic efforts, sometimes free flaps fail. Perforator free flaps are not invincible and can suffer the same fate. The real challenge is how to decide what is the next best choice for achieving the desired outcome.
Methods: Over the past decade, 298 free perforator flaps were used in our institution. Total failure occurred in 16 patients, and partial failure requiring a second free flap occurred in an additional 6 patients for a true success rate of 93%. All failures had some form of secondary vascularized tissue transfer, which included the use of muscle flaps in 9 (41%) different patients.
Results: Initial flap salvage after a failed perforator free flap was attempted with 12 perforator and 5 muscle free flaps as well as 1 perforator and 2 muscle local flaps. These were not all successful, with loss of 3 muscle free flaps and 3 perforator flaps. Tertiary free flap coverage was successful in 3 cases using 2 muscle flaps and 1 perforator free flap. Local fasciocutaneous flaps or primary wound closure was used in the remaining individuals.
Conclusions: Microsurgical tissue transfers can be the most rewarding and at the same time the most challenging reconstructive endeavor. Persistence in achieving the desired outcome can require multiple steps. Perforator flaps are an important asset to obtain this goal. However, muscle flaps can still be a useful alternative, and the message is that they should not be overlooked as sometimes a viable option. *(Plast Reconstr Surg Glob Open 2015;3:e564; doi: 10.1097/GOX.0000000000000537; Published online 20 November 2015.)*

Many consider that a microsurgical tissue transfer justifies occupation of the "penthouse" suite of the reconstructive elevator[1] not because of the technical complexity of the procedure, as success rates for microanastomoses even in community hospitals routinely exceed 95%,[2] but because of the respect for the potential ability of a microsurgical tissue transfer to replace any defect with any tissue composition in an incredibly short period of time. Yet as with any endeavor in life, the question "Should free flaps ever fail?"[3] must be answered in the affirmative as human imperfection cannot ever be totally escaped. The real question, if concern for the patient is of paramount importance, should then be as follows: "What is the next solution?"

According to Lineaweaver et al[4] in their impeccable review of the management strategies used by others to answer the aforementioned question, many would not attempt a second free flap and instead rely on more conservative options available in the lower

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floors of the reconstructive elevator.[1] This might be quite an acceptable approach if a more complete analysis of why failure occurred revealed some unrecognized patient risk factor such as irresolvable hypercoagulability,[5,6] but it is not acceptable if life or limb remained in jeopardy. Thus, if a free flap were truly indicated in the first place, it should still be indicated subsequently also. And a second attempt with free flap would be justifiable as the preferred solution.[7–10]

Although a complete understanding of the anatomical variations and physiology of perforator free flaps may always be elusive,[11] few can disagree that they have now become a mainstream choice in the realm of reconstructive surgery.[12] This relatively new flap concept not only maximizes donor-site function preservation but can also provide both large and small flaps from innumerable donor sites that can potentially emanate from perforator vessels of any desired caliber, with as long or as short a pedicle as desired to provide immense versatility. As with all free flaps though, failures can be anticipated. Modifying slightly the third law of the sage Vasconez,[13] if plan A is a perforator free flap, "don't make plan B identical to plan A." Yet every rule can have an exception as shown elsewhere that if a second perforator free flap (plan B) is used, success can still be reliably achieved.[14–16] Nevertheless, sometimes a better plan B is to use a more traditional standby such as a free or pedicled muscle flap. At the risk of being further ostracized by some of my colleagues who tend to use only perforator flaps, just when a muscle flap is indicated is further scrutinized here.

METHODS

A retrospective review of our institution's free flap registry for the past decade, from July 2005 to the present, listed 514 free flaps of all types that included the use of 298 (58%) perforator free flaps (Table 1). Of these 298 perforator free flaps, major complications occurred in 22 patients, as 16 (5%) had flap transfers that failed completely and 6 (2%) sustained partial failure requiring a second free flap. An analysis is made here to note any differences in the selection of a muscle vs perforator flap for initial flap salvage with respect to sex, etiology and nature of the problem, body region, and ultimate outcome for all patients (Table 2). Timing of the primary salvage attempt was defined as early if the attempt was done immediately during the initial flap transfer or concomitantly with a re-exploration (Table 3). An acute salvage attempt was performed within the first posttransfer week. Any other timeframe was considered a delayed attempt. Ultimate wound closure for all compromised cases was by use of a muscle flap at some step in 9 (41%) patients (Table 4).

RESULTS

Of the 298 perforator free flaps transferred at our institution in the past decade, overall the anterolateral thigh (ALT) flap was by far the most commonly selected donor site (56%) (Table 1) as this was considered an "ideal" soft-tissue flap primarily for lower extremity reconstruction mainly due to traumatic wounds (Table 2).[17] A distant second choice was the deep inferior epigastric artery perforator flap (19%) used most frequently for breast reconstruction. Total failure of the initial perforator free flap occurred in 16 patients, with 50% being ALT free flaps, resulting in an apparent 95% success rate. However, 6 patients had partial failures, which required a second free flap before completion of the planned reconstruction, so that the real flap success rate was 93%. All partial failures occurred in ALT free flaps, with a sec-

Table 1. Initial Flap and Salvage Maneuvers

				Initial Salvage Flaps					Secondary Salvage		
				Muscle		Perforator			Free Flaps		Other
Initial Flap		Failures		Free	Local	Free	Local		Muscle	Perforator	
ALT	167	Total:	8	2	1	4	1	Muscle:	—	—	2
		Partial:	6	1	—	5	—	Perforator:	1	1	—
Circumflex Scapular	9	None									
DIEAP	58	Total:	3	2	1	—	—		—	—	1
MCFAP	7	Total:	2	—	—	—	—		—	—	—
M/LSAP	27	Total:	3	—	—	3	—		1	—	—
Radial Forearm	9	None									
SIEAP	5	None									
Others*	16	None									
Total	298	Total:	16	5	2	12	1		2	1	3
		Partial:	6								

*None with more than 4 cases.
DIEAP, deep inferior epigastric artery perforator; MCFAP, medial circumflex femoral artery perforator; M/LSAP, medial/lateral sural artery perforator; SIEAP, superficial inferior epigastric artery perforator.

Table 2. Demographics of Salvaged Failed Flaps

	Ultimate Flap Salvage Technique		
	Muscle	Perforator	Other*
Sex			
Female	2	2	3
Male	4	11	—
Etiology			
Dysvascular	1	—	—
Iatrogenic	2	1	—
Trauma	2	9	2
Tumor	1	3	1
Concern			
Exposed			
Bone/joint	6	11	2
Tumor defect	—	2	—
Scar	—	—	1
Location			
Head and neck	2	4	—
Extremity	4	8	1
Trunk	—	—	1
Upper extremity	—	1	1
Total	6	13	3

*Local fasciocutaneous flaps.

Table 3. Timing of First Salvage Flap

	Muscle		Perforator	
Total Failed Flap	Free	Local	Free	Local
Early				
Immediate	1	2	3	—
Re-exploration	1	—	—	—
Acute	1	—	5	1
Delayed	2	—	6	—
Total	5	2	14	1

Table 4. Muscle Flap Utilization for Salvage Perforator Flaps

	Initial Salvage Flap		Second Salvage Option	
Failed Flap	Free	Local	Free Flap	Other†
ALT	Gracilis,* 2 LD, 1	MG, 1 LD, 1	Gracilis, 1	—
DIEAP	LD, 1 TUG, 1†	Soleus, 1	—	None, 1
MSAP	—	—	Gracilis, 1	—

*Both failed.
†Failed, with primary chest wall closure salvage.
DIEAP, deep inferior epigastric artery perforator; LD, latissimus dorsi; MG, medial gastrocnemius; MSAP, medial sural artery perforator; TUG, transverse upper gracilis.

ond perforator free flap used to salvage all failures in this subgroup except 1 for which a latissimus dorsi (LD) free muscle flap was chosen. All these secondary free flaps were successful.

Case Report: Muscle Free Flap Salvage of Partially Failed Perforator Free Flap

A male patient aged 68 years developed a recurrent squamous cell carcinoma of the vertex of his scalp that was treated with radiation therapy. He was lost to follow-up for 3 years and then returned with an area of osteoradionecrosis and exposed skull (Fig. 1). Preoperative medical clearance revealed an unrelated, unresectable right lung cancer. During this 4-month medical delay, he was admitted twice for a subdural abscess, which was treated by his neurosurgeon.

A combined neurosurgical procedure was considered at least palliative to remove all of the infected skull. This was followed by an uneventful coverage of the defect with a left ALT free flap using a short vein graft to reach the left superficial temporal artery as the recipient site. In the follow-up done 18 days postoperatively, it was found that the distal end of the flap had become gray, with erythema of the scalp around the flap. Progressive skin and fat necrosis ensued, which resulted again in skull exposure after serial debridement. Another free flap was indicated for skull coverage as the irradiated scalp could not be safely used as a local flap. Thirty-seven days after the use of the first free flap, the left LD muscle was rapidly harvested as a salvage maneuver using the right superficial temporal vessels as the recipient site. The pliable muscle was placed underneath the residual distal end of the ALT flap to ensure total skull coverage even if more of the latter would later prove to be nonviable. Yet total healing then occurred. Unfortunately, the patient died 4 months later from his lung cancer.

Most failures of perforator free flaps were in trauma patients who had lower extremity wounds with still exposed joint or fracture (Table 2). Vascularized tissue coverage was still considered imperative. Of the 16 patients who had a total perforator free flap failure, 13 had a second free flap attempt, whereas the other 3 had local flaps. One of the latter was a pedicled perforator flap that partially necrosed with the bone still exposed, requiring yet a third attempt with a muscle free flap before the limb was salvaged.

Case Report: Muscle Free Flap Salvage of Failed Perforator Free and Pedicled Flap

A slightly overweight, diabetic 66-year-old man, with neuropathy of his feet and reasonable pedal pulses despite some atherosclerosis, stepped on a clamshell leading to a nonhealing wound and exposure of his right calcaneus (Figs. 2, 3). Attempts to skin-graft this area by others over the next few months were unsuccessful. The patient adamantly refused an amputation of his leg. To cover the bone, a right ALT free flap was selected as the best choice as local flaps were considered either too small or precarious as least as regards their circulation. The posterior tibial recipient site was found to be extremely

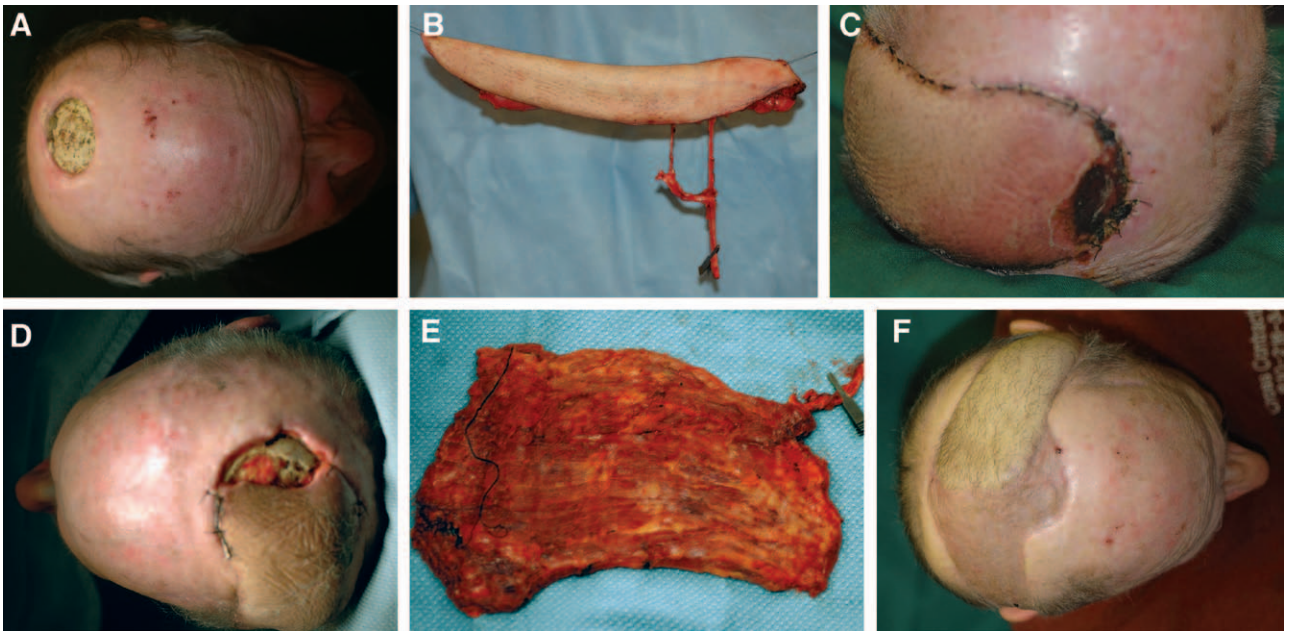

Fig. 1. A, Exposed skull within radiation field of vertex of the scalp; B, ALT free flap used for initial coverage; C, distal end of initially viable ALT flap became necrotic with surrounding area of cellulitis; D, after debridement of the ALT flap, the distal portion still appeared ischemic but marginally viable, and the skull was again exposed; E, left LD muscle free flap used as a salvage free flap for this partial failure; F, finally healed scalp with ALT free flap on the left overriding part of LD free flap on right that was otherwise skin grafted.

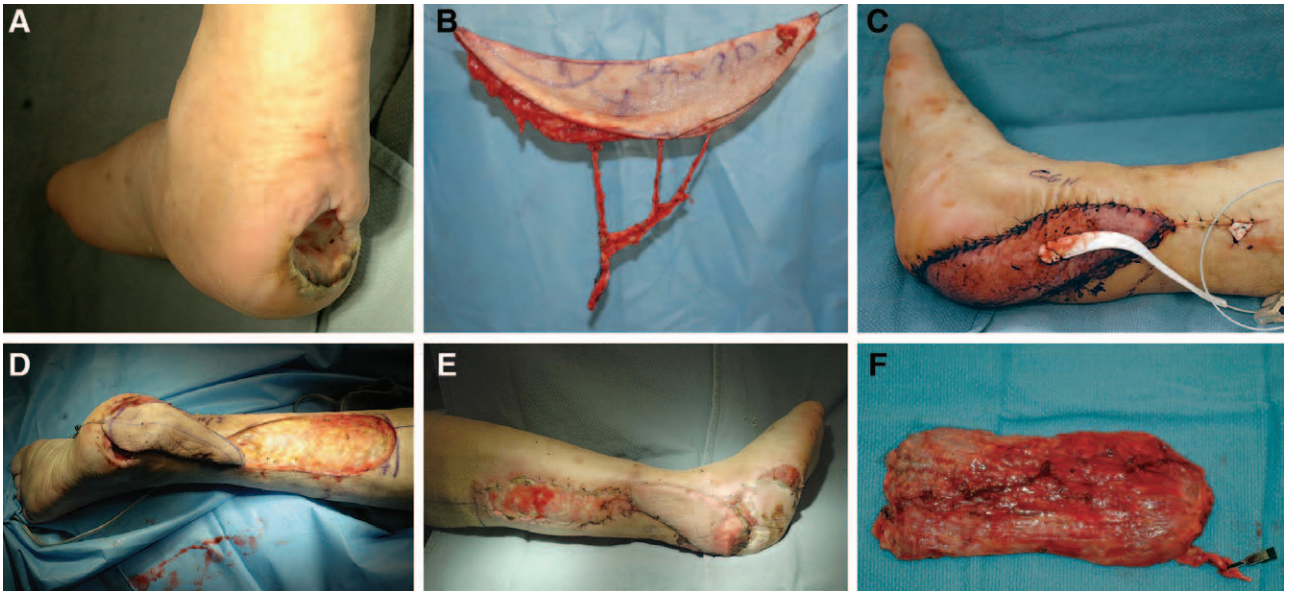

Fig. 2. A, Exposed calcaneus in chronic right posterior hindfoot wound; B, ALT free flap used for initial coverage; C, irreversible venous congestion of ALT flap; D, acute transfer of distal-based sural flap pedicled on peroneal perforator appears viable as the attempted salvage flap for heel coverage; E, the distal-based sural flap portion covering the heel defect progressively underwent necrosis; F, LD muscle free flap as the second-attempt salvage flap.

fibrotic because of the long-standing inflammatory response from his open wound. With difficulty, the flap artery was anastomosed end-to-side to the posterior tibial artery, and vein was anastomosed to a posterior tibial vena comitans. Initial perfusion was adequate, but the next day venous congestion was apparent, requiring an emergent re-exploration. Ironically, arterial inflow persisted, but venous outflow could never be restored. Realizing these unanticipated recipient-site conditions inimical to reestablish-

Fig. 3. Skin-grafted LD free flap successfully closed the heel wound. Note remnant of distal-based sural flap posterior to the bulky LD flap.

ing flow to a free flap, 3 days later, we turned down a distal-based sural flap (even though the patient was diabetic, morbidly obese, with known atherosclerosis) as the only reasonable local flap option to cover the heel. Over the course of the next week, the tip of that flap also turned cyanotic progressively.

Again, the patient refused to consider a leg amputation. He agreed to the high risk of failure of a second-attempt free flap, and this time his right LD muscle was used to reach the anterior tibial vessels as the second recipient site above the ankle. This flap totally survived uneventfully, although the patient, now 6 months after the use of the second flap, later has a very bulky foot even with the relatively thin muscle flap. He does ambulate on the sole of this foot and refuses any further procedures.

Of the 13 second-attempt free flaps used for salvage of flaps that had totally failed, 7 (54%) were completely successful. Three patients required yet a third free flap that finally survived, and by definition, this was a delayed procedure. Two of these were muscle free flaps (Table 1). The timing of early interventions was evenly distributed between flap subgroups, but usually a second perforator free flap was used if there was any delay (Table 3). The consensus for an early second flap at the initial operation or re-exploration was to take advantage of the same exposed recipient vessels because of easy accessibility.

Muscle flaps were chosen overall as the salvage flap for 9 patients (Table 4). Six of these patients had had a vein graft for the first perforator free flap, whereas only 1 patient did in the salvage perforator free flap group. Six muscle flaps were ultimately successful, presumably partially, because the long length of the muscle selected could be used in lieu of the risk of a vein graft otherwise needed to reach the recipient site. Of the 3 muscle flap failures, 2 gracilis free flaps required salvage by a local fasciocutaneous flap. One second-attempt breast reconstruction using a transverse upper gracilis flap reverted to direct chest-wall closure pending fat grafting.

DISCUSSION

Free flap failures are uncommon but not rare. Perfection may be an elusive goal, but a good outcome usually will still require some form of vascularized tissue coverage. Preservation of life or limb, therefore, justifies a second attempt that many have shown to be highly successful.[7–10] Perforator flaps offer a wide range of potential donor sites to serve not only as the primary selection for a given defect but also as a reasonable backup option.[15,16] However, as with any choice of a secondary flap, a careful analysis of the patient's condition must first be undertaken to confirm whether or not such an alternative is an appropriate option.[6]

Despite the current publicity for perforator flaps, muscle flaps are not yet passe.[18] Although not a panacea, muscle flaps have a limited but not negligible value as seen in this experience. Muscle flaps can be rapidly harvested in emergent situations where speed is of the essence as the anatomy is rarely anomalous, and even the experienced surgeon knows that perforator flap harvest requires a careful, delicate microdissection.[19] Often, the first-chosen perforator flap had the ideal contour for the given defect, and unfortunately, especially in the Western Hemisphere, other choices would just be too bulky. Sometimes the deep inferior epigastric artery perforator flap has been chosen only for the secondary gain of body recontouring, with also a donor scar easily hidden, while not respecting totally recipient-site requirements.[20] A relatively thin muscle flap would then be the next best choice perhaps even from the beginning. A muscle-only flap always permits direct closure of the donor site, leaving a linear scar as opposed to the poor aesthetic residue if the perforator flap donor site must be skin grafted. The risk of vein grafts can sometimes be avoided by using a long muscle flap instead to reach the recipient site. Finally, if one believes in the "true" perforator flap concept,[21] after raising a perforator flap on a musculocutaneous perforator, the underlying muscle should remain relatively unharmed and can itself still be used secondarily as a local or free muscle flap that will further restrict secondary donor-site morbidity![22]

CONCLUSIONS

Most undesirable sequelae after any free flap failure may best be avoided by a second free flap attempt.[7–10] This does not mean that if a perforator free flap fails then a second perforator free flap

must be done, although that might still best satisfy the demands of the given defect.[15,16] Another choice to consider is a muscle flap that, depending on the defect location, can even be a local muscle transposition. Remember that every muscle has a function and that specific contribution will be lost if it must be used as an adynamic transfer. Muscles also atrophy over time, and contour will be altered. Muscles usually need to be skin grafted, which will always lead to an inferior aesthetic result when compared with a properly chosen perforator flap. Nevertheless, a role still exists for muscle flaps under the proper circumstances as reiterated here, and this option should not be forgotten.

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